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Final
Baseline Ecological Risk Assessment
SWMUs 1 and 15
Naval Air Station Oceana
Virginia Beach, Virginia

Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-93-D-6007
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June 2001

Prepared by

CH2MHILL

Baker
Environmental, Inc.

CDM
Federal Programs Corp.

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SIGNATURE PAGE

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Prepared by

CH2M HILL

June 2001

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Table of Contents

List of Tables

List of Figures

List of Appendices

Acronyms and Abbreviations

AUF	Area Use Factor
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
BERA	Baseline Ecological Risk Assessment
BGS	Below Ground Surface
BTAG	Biological Technical Assistance Group
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CMS	Corrective Measures Study
CNO	Chief of Naval Operations
COPC	Chemical of Potential Concern
DNH	Division of Natural Heritage
DQO	Data Quality Objective
ERA	Ecological Risk Assessment
FOD	Frequency of Detection
FOE	Frequency of Exceedence
FS	Feasibility Study
GW	Groundwater
HQ	Hazard Quotient
IAS	Initial Assessment Study
IR	Installation Restoration
K_d	Adsorption coefficient
K_{ow}	Octanol-water partition coefficient
K_{oc}	Adsorption coefficient normalized to total organic carbon
LD_{50}	Lethal Dose (50 percent of the population)
LOAEL	Lowest Observed Adverse Effect Level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mlw	Mean low water
mph	Miles per hour
MSL	Mean sea level
MW	Monitoring Well
NAS	Naval Air Station
NFA	No Further Action
NOAEL	No Observed Adverse Effect Level
NWI	National Wetlands Inventory
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls

ppm	Parts per million
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RGH	Rogers, Golder, and Halpern
RI	Remedial Investigation
SD	Sediment
SERA	Screening Ecological Risk Assessment
SLC	Screening Level Concentration
SS	Surface Soil
SVOC	Semivolatile Organic Compound
SW	Surface Water
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCL	Target Compound List
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TPV	Total Petroleum Volatiles
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VADEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compound
VPDES	Virginia Pollution Discharge Elimination System
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter

Executive Summary

This report presents a baseline (Step 3) ecological risk assessment (BERA) for two Solid Waste Management Units (SWMUs 1 and 15) on Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. This Step 3 ERA was conducted in accordance with the Navy Policy for Conducting Ecological Risk Assessments (CNO 1999) and the Navy/Tier II ERA approach developed for Region 3. The CNO policy, which describes a process consisting of eight steps organized into three tiers, is a clarification and interpretation of the eight-step process outlined in U.S. Environmental Protection Agency (USEPA) ERA guidance for the Superfund program (USEPA 1997).

The general objectives of the Step 3 ERA are to: (1) refine the risk estimates from the screening ERA to determine if risks to ecological receptors from site-related chemicals are likely to occur based on realistic exposure scenarios; and (2) focus subsequent data collection activities if potential risks are indicated, uncertainties are unacceptably high, and/or data gaps are identified.

Potential risks to soil invertebrates utilizing SWMU 1 are expected to be low to moderate but occur only in an isolated area. The few COPCs that cause risk in surface soil were generally consistent with background soil concentrations. No COPC exceeded both a screening value and an upgradient concentration in surface water or sediment. No HQ for food web exposures for either terrestrial or aquatic receptors exceeded one based on a LOAEL. Considering the relatively low habitat value of these ditches (which are periodically maintained as part of the stormwater system) and the likelihood that upper trophic level receptors would forage elsewhere (where habitat quality was better) much of the time, risks to these species are likely to be negligible.

Potential risks to aquatic organisms utilizing SWMU 15 are expected to be low based on the magnitude of the sediment and food web exceedences. Potential risks to upper trophic level terrestrial organisms utilizing SWMU 15 are low. Potential risks to lower trophic level terrestrial organisms (e.g., soil invertebrates) are relatively high based on the magnitude of the surface soil exceedences for PAHs, however, they occur in an isolated area.

Based upon the results and the certainty associated with the results, the relative size of these SWMUs, and the proximity of these SWMUs to an active military runway/airfield, site specific toxicity testing or additional sampling on which to base remedial action decisions is not warranted. Therefore, no further study in the risk assessment is recommended at this time. The identified potential for risks to ecological receptors will be further addressed in the remedial alternatives in the feasibility study being drafted for these SWMUs.

A Draft Feasibility Study (FS) is being prepared to develop remedial action objectives (RAOs) and alternatives for SWMUs 1 and 15. Site-specific remedial alternatives developed in the Draft FS were developed for SWMUs 1 and 15, based upon the results of previous investigations and risk assessments. The site-specific remedial alternatives for SWMU 1 are: (1) Minimize direct contact of human receptors with surface soil that may pose unacceptable risks from residential use of the soil, and (2) prevent unacceptable risks to potential human receptors to the groundwater. The specific remedial alternatives for SWMU 15 are: (1) Minimize direct contact of human receptors with surface soil that may pose unacceptable risks, and (2) prevent unacceptable risks to potential receptors to the groundwater (consumptive and non-consumptive). In order to be protective of ecological health, the Final Feasibility Study will also evaluate the ecological risk as defined in Tables 8-1 and 8-2 and other supporting documentation.

1.0 Introduction

This report presents the first step (Step 3) of a baseline ecological risk assessment (BERA) for SWMUs 1 (West Woods Oil Pit) and 15 (Abandoned Tank Farm) at Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. Figure 1-1 shows the location of these SWMUs. A screening ecological risk assessment (SERA), constituting Steps 1 and 2 of the ecological risk assessment (ERA) process, was completed for SWMUs 1 and 15 in July 2000 (CH2M HILL 2000a).

This Step 3 ERA is conducted in accordance with the Navy Policy for Conducting Ecological Risk Assessments (CNO 1999) and the Navy/Tier II ERA approach developed for Region 3. The CNO policy, which describes a process consisting of eight steps organized into three tiers, is a clarification and interpretation of the eight-step process outlined in U.S. Environmental Protection Agency (USEPA) ERA guidance for the Superfund program (USEPA 1997). The major differences between the Navy ERA policy and the USEPA ERA guidance are: (1) the Navy policy provides clearly defined criteria for exiting the ERA process at specific points, (2) the Navy policy divides Step 3 (the first step of the baseline ERA) into two distinct sub-steps (Steps 3A and 3B), with a potential exit point after Step 3A, and (3) the Navy policy incorporates risk management considerations throughout all tiers of the ERA process.

In Step 3A, a refined evaluation of media concentrations and exposure estimates is conducted using more realistic assumptions and additional methodologies relative to those used in the SERA, which is intended to be a very conservative assessment. Examples of more realistic exposure assumptions include using central tendency estimates (rather than maximums) for media concentrations, bioaccumulation factors, and exposure parameters. Examples of additional methodologies, where applicable, include consideration of upgradient and background concentrations, detection frequency, and bioavailability (CNO 1999).

If risk estimates (and their associated uncertainty) are acceptable following Step 3A, the site will meet the conditions of the exit criterion specified in the Navy guidance and the ERA process will terminate. If the Step 3A evaluation does not support an acceptable risk determination, the site continues to Step 3B.

In Step 3B, the preliminary conceptual model presented in the SERA is refined based on the results of Step 3A to develop a revised list of receptors, Chemicals of Potential Concern (COPCs), assessment endpoints, measurement endpoints, and risk hypotheses. Based upon the revised conceptual model, the lines of evidence to be used in characterizing risk are determined.

1.1 Objectives

The general objectives of the Step 3 ERA are to:

- Refine the risk estimates from the SERA to determine if risks to ecological receptors from site-related chemicals are likely to occur based on realistic exposure scenarios
- Focus subsequent data collection activities if potential risks are indicated, uncertainties are unacceptably high, and/or data gaps are identified

At the conclusion of Step 3, there are three possible decision points:

- **No further ecological investigation or evaluation is warranted.** This decision is appropriate if the evaluation indicates that sufficient data are available on which to base a conclusion that there is no risk that is within acceptable uncertainty or there is risk that is within acceptable uncertainty.

- **Further data are required.** This decision is appropriate if the evaluation indicates that the potential for unacceptable risk exists and additional data to refine these estimates (e.g., additional analytical data, measures of bioavailability) are needed. In this case, the site continues to Step 4 of the ERA process.
- **Take remedial action.** This decision may be appropriate for circumstances in which the potential for unacceptable risks was identified but these potential risks could best be addressed through remedial action (e.g., presumptive remedy, soil removal) rather than additional study.

1.2 Report Organization

This report is divided into the following sections:

- **Section 1.0 - Introduction.** Describes the purpose and scope of the ERA and outlines the report organization.
- **Section 2.0 - Facility Background.** Describes the environmental setting of NAS Oceana.
- **Section 3.0 - General Approach and Methodology.** Outlines and describes the specific technical approaches, methodologies, models, and parameter values that are used in the ERA.
- **Section 4.0 – SWMU 1 - West Woods Oil Pit.** Describes the results and conclusions of the risk evaluation for SWMU 1.
- **Section 5.0 – SWMU 15 - Abandoned Tank Farm.** Describes the results and conclusions of the risk evaluation for SWMU 15.
- **Section 6.0 - Uncertainties.** Identifies and discusses the sources of uncertainty in the ERA and evaluates their potential impacts on the risk conclusions.
- **Section 7.0 - Conclusions.** Summarizes the results of the ERA and presents the conclusions for each site.
- **Section 8.0 – Risk Management.** Describes the risk management options for SWMUs 1 and 15.
- **Section 9.0 – References.** Lists the citations for all references cited in the report.

Supporting technical data are provided in appendices.

2.0 Facility Background

This section describes the environmental setting (e.g., habitats and biota) of NAS Oceana as well as the analytical data available for use in this ERA. NAS Oceana is located in the Tidewater region of Virginia and lies southeast of the city of Norfolk, immediately west of the Atlantic Ocean, and just south of the Chesapeake Bay. NAS Oceana consists of approximately 6,000 acres within the city of Virginia Beach.

More than 40 percent of the base is urbanized including commercial, residential, and operations buildings, and runways, hangars and similar structures. The undeveloped areas of the base consist of farmland, open land, forest, and wetlands. Farmland comprises approximately 925 acres. The land is farmed by private producers under the Navy's agricultural outlease program (Nair 1988). Major crops grown within the boundaries of the base are corn, soybeans, and winter wheat. Approximately 200 acres of open fields and meadows, and 600 acres of forest occur on NAS Oceana (RGH 1984). The forested areas on the base are dominated by pine, mixed pine-hardwood, and hardwood stands.

Wetlands comprise approximately 660 acres of the undeveloped areas (CH2M HILL 1993). The U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) maps classify the wetlands as palustrine emergent (PEM), palustrine scrub/shrub (PSS), and palustrine forested (PFO) (USFWS 1991). In addition to relying on the NWI mapping of wetlands, field observations by CH2M HILL ecologists and Army Corps of Engineers wetlands biologists were used to verify the existence of wetlands on NAS Oceana and each specific SWMU.

2.1 Environmental Setting

2.1.1 Physiographic Features

2.1.1.1 Climate

NAS Oceana is located near the Atlantic Ocean, which accounts for the mild year-round temperatures. The Virginia Beach area climate is characterized by hot, humid summers and mild winters. The annual temperature is 68.2 degrees F with an average annual precipitation of 44.62 inches. Seasonal snowfall is approximately 7 inches annually. Average wind speed at the station is approximately 10 mph. Coastal storms, in the form severe thunderstorms, northeasters, and hurricanes, frequently impact the station.

2.1.1.2 Topography

The elevation of the station ranges from approximately 5 feet above mean sea level (MSL) in the drainage ditches to approximately 25 feet above MSL in the open fields. Elevations in the developed area of the station range from 10 to 25 feet above MSL. The topography of the station is generally flat with a general easterly slope to the land surface.

2.1.1.3 Soils

NAS Oceana is on the outer edge of the Atlantic Coastal Plain physiographic province. The Atlantic Coastal Plain is a broad wedge of unconsolidated sediments that dip and thicken to the east. In the area of NAS Oceana, the sediments consist of several thousand feet of unconsolidated sand, clay, silt, and gravel, and are underlain by granite basement rock.

The geologic units of concern in the environmental investigations at NAS Oceana are the Yorktown Formation and the Columbia Group. The Yorktown Formation consists of interbedded layers of shelly, very fine to coarse sands, clayey sands and sandy clay. Shelly layers are common in the Yorktown (Meng and Harsh 1984). Siudyla et al. (1981) divided the Yorktown into three sand units each overlain by a confining layer of silt and clay.

Regionally, the uppermost of these silt and clay beds, which is referred to as the Yorktown confining unit, separates the Yorktown Formation from the sediments of the Columbia Group that overlie it. This uppermost bed consists of massive, well-bedded yellow-gray to greenish-gray clays and silty clays, which commonly contain shells, fine sand, and mica. The clay layers within the confining bed are generally extensive but are a series of coalescing clay beds rather than a single deposited unit. This unit was deposited in a shallow open-marine environment of broad lagoons and quiet bays (Meng and Harsh 1984).

2.1.1.4 Surface Water Resources

Surface runoff from the station is facilitated by a system of drainage ditches and surface canals that flow south and west to West Neck Creek, north to London Bridge and Great Neck Creek, and east to Owls Creek and Lake Rudee (Figure 1-1). Surface water bodies on the station are limited to these drainage ditches and a number of man-made ponds.

2.1.1.5 Groundwater Resources

Groundwater at NAS Oceana is generally within 4 to 10 feet of the land surface. Aquifer conditions are unconfined in the Columbia Group and unconfined to semi-confined within the upper Yorktown Formation (Siudyla et al. 1981). When the clay confining unit overlying the Yorktown is absent, the upper Yorktown is generally unconfined. Natural groundwater flow directions are generally south to southeast, but flow direction is controlled locally by drainage ditches. The flow direction in the Virginia Beach area is therefore highly variable because of the complexity of the drainage patterns.

2.1.2 Habitats and Biota

2.1.2.1 Flora

A wide variety of vegetation types occur at NAS Oceana. Table 2-1 lists the plant species known or expected to occur on the station. Approximately 600 acres of forest and 200 acres of open land comprise the undeveloped areas at NAS Oceana (RGH 1984). Approximately 660 acres (11 percent) of the land area at NAS Oceana are wetlands.

Most of the forested areas on the station are dominated by pine, mixed pine-hardwood, and hardwood stands. Areas with poorly drained, saturated soils are dominated by sweetgum, red maple, and, sometimes, loblolly pine. Most forested stands with unsaturated or moist soil conditions are dominated by loblolly pine or mixed pine-hardwoods. Upland forested areas usually have more oaks and cherry. Other overstory species likely to occur with these species are water oak, southern red oak, swamp chestnut oak, willow oak, tulip poplar, and black gum. Understory vegetation in the hardwood stands is dominated by switch cane. Other species occurring in the hardwood understory include greenbrier, pawpaw, Japanese honeysuckle, and bayberry. Understory plants that commonly occur in loblolly forests include sparse stands of switch cane, greenbrier, and Japanese honeysuckle.

2.1.2.2 Fauna

Observations of mammals, birds, reptiles, and amphibians, or their signs, were recorded during a 1992 on-site survey of the NAS (CH2M HILL 1993). Only six mammalian species were observed during the survey: white-tailed deer, raccoon, chipmunk, squirrel, field mouse, and red fox. These species were observed in the forested areas around the station or in over-grown areas in the developed portion of the station. Table 2-2 lists mammals known or expected to inhabit NAS Oceana.

Many species of birds use the station as seasonal and year-round habitat. The on-site survey was conducted during early winter when many of the resident birds have migrated to their wintering grounds. Therefore, only a few species were observed during the survey. The yellow-rumped warbler, which occurred in large numbers on the edges of forested areas throughout the station, was observed more than any other species of bird. Other species observed during the survey include starlings, crows, gulls, song sparrows, ovenbirds, blue jays, cardinals, and common flickers. A list of birds known or expected to occur on the station is included in Table 2-3.

Habitat exists on the station for a wide variety of reptiles and amphibians. However, because the on-site survey was conducted in early winter, only two species of reptiles, eastern painted turtle and a slider turtle, were observed. Green frogs and bullfrog tadpoles were prevalent in some of the small shallow ponds throughout the station. Lists of reptiles and amphibians known or expected to occur on the station are shown in Tables 2-4 and 2-5, respectively.

Fishery resources are largely limited to the ponds at the inactive landfill/sand pit, and the borrow pond on the outskirts of the station. Largemouth bass and bluegill are known to exist in these ponds. Some of the ditches and creeks on the station had low numbers of mosquito fish and mud minnows. Mosquito fish were once stocked in several ditches on the station to cut down on mosquito populations (CH2M HILL 1993). Table 2-6 lists fish species known or expected to occur on the station.

Because the sediment was not sampled during the 1992 on-site ecological survey, no benthic organisms were observed in any of the water bodies on the station. Benthic organisms probably exist in all of the water bodies on and adjacent to the station.

2.1.2.3 Rare, Threatened, and Endangered Species

An inventory of rare, threatened, and endangered vertebrate and plant species was conducted on NAS Oceana in 1989 by the Virginia Department of Conservation and Recreation, Division of Natural Heritage (DNH), and was published in a Natural Heritage Technical Report (DNH 1990). These results were updated and verified by checking the DNH, VA Department of Game and Inland Fisheries, and USFWS web sites for rare and endangered species. (http://www.dcr.state.va.us/dnh/rare.htm, http://www.dgif.state.va.us/wildlife/index.cfm, and http://endangered.fws.gov/). The updated information, in conjunction with the earlier DNH report (DNH 1990) suggests that no rare, threatened, or endangered wildlife species are known to occur at NAS Oceana, with the possible exception of occasional transient species (CH2M HILL 1993). These species are discussed below. Several rare plant species have been found on the station (see below).

Wildlife. The following three listed species reside or migrate through southeastern Virginia and could be found at the station:

- Peregrine falcon (*Falco peregrinus*). Listed as endangered in the commonwealth of Virginia, the peregrine falcon can be found in coastal areas during migration, particularly in September and October. In addition, hacking stations (release areas) have been established for the peregrine falcon on the Eastern Shore and in Back Bay National Wildlife Refuge (RGH 1984).
- Bald eagle (*Haliaeetus leucocephalus*). This species is listed as threatened in the commonwealth of Virginia and in portions of the lower 48 United States. The bald eagle was proposed for removal from the federal list in July 1999. Virginia provides prime habitat for the bald eagle. In 1978, 37 active nests were located in the state (RGH 1984). There are currently no known bald eagles nesting in the immediate area of NAS Oceana. Some birds, however, do winter along area beaches or pass through the region during migration.

- Swainson's warbler (*Limnothlypis swainsonii*). This species is known to inhabit areas with abundant giant cane. This habitat was once common in Virginia Beach and is found on NAS Oceana. The findings of the DNH technical report (DNH 1990) are that only marginally suitable habitat was found at the station for this species.

A list of rare wildlife species that may occur in the vicinity of NAS Oceana was generated from the natural heritage database and is presented in Table 2-7 (DNH 1990).

Other rare, threatened, or endangered wildlife species that historically were likely to occur on the station are the following:

- Red-cockaded woodpecker (*Picoides borealis*)
- Many-lined salamander (*Stereochilus marginatus*)
- Greater siren (*Siren lacertina*)

The red-cockaded woodpecker was sighted in Suffolk, approximately 30 miles away from NAS Oceana, during the summer of 1984 (Nair 1988). No sightings have occurred since 1984. The many-lined salamander was found in a sandy-bottomed stream within a few miles of NAS Oceana, but the exact location of this sighting or the date could not be determined (DNH 1990). The greater siren was recorded early in this century and in the 1950s at Dam Neck Lake and Indian Creek (DNH 1990). No recent specimens of either of these salamanders are known.

Plants. A list of rare plant species that may occur in the vicinity of NAS Oceana was generated from the natural heritage database and is presented in Table 2-8 (DNH 1990). One state-listed rare plant species was observed during the on-site survey of the station. This species was the long-leaf pine (*Pinus palustris*), which is listed as extremely rare in Virginia. A grove of long-leaf pine was planted in the early 1980s near the sandpit area at Site 22 as an experiment to determine if the species could be successfully grown at NAS Oceana for commercial harvesting (CH2M HILL 1993). Commercial use of long-leaf pine at NAS Oceana was determined to be infeasible; however, the stand that exists on the site serves aesthetic purposes. The DNH did not consider this particular stand of long-leaf pines to be an important natural resource to be protected because the trees were planted (CH2M HILL 1993).

The southern twayblade (*Listera australis*) also is known to occur on the station. This species is listed as very rare in Virginia. Eighteen individuals were located during the species inventory conducted by DNH in 1989. The plants were found in the area referred to as the Northwest Woods Special Interest Area. *Listera australis* was recommended for special concern status in 1989 (DNR 1990).

2.2 Sources of Available Analytical Data

The sources of analytical data are described in detail in Sections 4.1.2 and 5.1.2. The rationale for selecting which data to use at each SWMU is provided in Section 3.3.1 as well as in each site-specific section.

3.0 General Approach and Methodology

This section describes the specific technical approaches, methodologies, models, and parameter values that are used in the evaluation. To provide the proper context for the refined analysis conducted as part of Step 3A, certain parts of the problem formulation from the SERA are also summarized in this section and in Sections 4 and 5.

3.1 Problem Formulation

Problem formulation establishes the goals, scope, and focus of the risk assessment. As part of the screening-level problem formulation conducted in the SERA (CH2M HILL 2000a), the environmental setting of SWMUs 1 and 15 was characterized in terms of the habitats and biota known or likely to be present, and the types and concentrations of chemicals that are present in ecologically relevant media. This information is provided, in updated form, in Sections 4 and 5. Conceptual models were also developed for the SWMUs that described potential sources, potential transport pathways, potential exposure pathways and routes, and potential receptors (see Figures 4-2 and 5-2). The assessment endpoints, measurement endpoints, and risk hypotheses selected for evaluation are presented in Table 3-1. This selection was based upon fate, transport, and toxicological properties of the chemicals present at the SWMUs.

3.1.1 Exposure Pathways and Routes

An exposure pathway links a source of contamination with one or more receptors through exposure via one or more media and exposure routes. Exposure, and thus potential risk, can only occur if complete exposure pathways exist. Figures 4-2 and 5-2 show the complete exposure pathways to ecological receptors.

An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. Consistent with the approach taken in the SERA, dermal and inhalation exposures for upper trophic level receptor species are not considered significant relative to ingestion exposures and are therefore not evaluated in this ERA based on the general fate properties (e.g., relatively high adsorption to solids) of the chemicals commonly present on these sites (generally metals and PAHs) and the protection offered by hair or feathers. Upper trophic-level receptors considered in this ecological risk assessment would not likely be exposed to significant airborne sources of chemicals because the sites are vegetated and little wind erosion of topsoil would be expected. Furthermore, the primary chemicals on the sites, metals and PAHs, typically adsorb to soil suggesting the potential for volatilization and thus exposure via inhalation is limited. Incidental ingestion of soil/sediment during feeding, preening, or grooming activities is, however, considered in the risk estimates.

3.2 Effects Evaluation

The purpose of the effects evaluation is to establish chemical exposure levels (screening values) that represent conservative thresholds for adverse ecological effects. One set of screening values is developed for each selected assessment endpoint. The screening values used in this ERA are the same as the values used in the SERA. Medium-specific screening values for surface water, sediment, and surface soil are summarized in Table 3-2.

Ingestion screening values for dietary exposures were derived for each avian/mammalian receptor species and chemical evaluated in the ERA. Toxicological information from the literature for wildlife species most closely related to the receptor species was used, where available, but was supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) where necessary. The ingestion screening values are expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day).

Growth and reproduction were emphasized as assessment endpoints since they are the most relevant, ecologically, to maintaining viable populations and because they are generally the most studied chronic toxicological endpoints for ecological receptors. If several chronic toxicity studies were available from the literature, the most appropriate study was selected for each receptor species based on study design, study methodology, study duration, study endpoint, and test species. No Observed Adverse Effect Levels (NOAELs) based on growth and reproduction were utilized, where available, as the primary screening values. The same practice of applying uncertainty factors used in the SERA (CH2M HILL 2000a) was used in this ERA. When chronic NOAEL values were unavailable, estimates were derived or extrapolated from chronic Lowest Observed Adverse Effect Levels (LOAELs) or acute values as follows:

- When values for chronic toxicity were not available, the median lethal dose (LD_{50}) was used. An uncertainty factor of 100 was used to convert the acute LD_{50} to a chronic NOAEL (i.e., the LD_{50} was multiplied by 0.01 to obtain the chronic NOAEL).
- An uncertainty factor of 10 was used to convert a reported LOAEL to a NOAEL.

Ingestion screening values for mammals and birds are summarized in Tables 3-3 and 3-4, respectively.

3.3 Exposure Estimate

The results of the SERA (CH2M HILL 2000a) indicated that, based on a set of conservative exposure assumptions, a number of chemicals may pose a potential risk to one or more ecological receptors at SWMUs 1 and 15. These chemicals are discussed in Sections 4 and 5. This set of preliminary COPCs includes chemicals with hazard quotients (HQs) equal to or in excess of 1 (based on maximum exposures) and chemicals for which assessment data were not available.

According to Superfund guidance (USEPA 1997), Step 3 initiates the problem formulation phase of the baseline ERA. Under Navy guidance (CNO 1999), the baseline ERA begins with a preliminary step (Step 3A) in which the conservative assumptions employed in the screening ERA are refined and risk estimates are recalculated using the same conceptual model for the site. The re-evaluation may also include consideration of background data and the frequency at which chemicals were detected (CNO 1999). This reevaluation would only be used when there is adequate spatial sampling intensity.

The assumptions, parameter values, and methods that were modified for the Step 3A re-evaluation included:

- Evaluations of risk based on maximum chemical concentrations were supplemented by average (arithmetic mean) chemical concentrations and spatial distribution of samples. For upper trophic level receptors, mean chemical concentrations provide a more refined estimate of the likely level of chemical exposure because their populations would be expected to be found in several different areas of the site and, in many cases, off-site. In cases where adequate spatial sampling coverage exists, the mean concentrations may be appropriate for evaluating potential risks to populations of lower trophic level terrestrial and aquatic receptors because the members of the population are expected to be found throughout the site where habitat is present rather than concentrated in one particular area.

- Bioaccumulation factors (BAFs) and bioconcentration factors (BCFs) were based on, or modeled from, central tendency estimates (e.g., median or mean) from the literature as opposed to the maximum or "high-end" (e.g., 90th percentile) estimates used in the SERA from many chemicals.

- Central tendency estimates (e.g., mean, median, midpoint) for body weight and ingestion rate (Table 3-5) were used to develop exposure estimates for upper trophic level receptors, rather than the minimum body weights and maximum ingestion rates used in the SERA. The use of central tendency exposure parameter estimates is more relevant because they represent the characteristics of a greater proportion of the individuals in the population.

- In addition to the NOAELs used in the SERA, consideration is also given to risk estimates based on LOAELs.

- Chemicals that were not detected but were retained as COPCs in the SERA because: (1) the maximum reporting limit exceeded the respective screening value, or (2) no screening value was available, were not further evaluated in Step 3A. This focussing on selected chemicals and not on other chemicals is discussed in Section 6.0 Uncertainty.

3.3.1 Selection Criteria for Analytical Data

Available analytical data (described in Sections 4.1.2 and 5.1.2) were selected for use in the ERA based on a set of selection criteria that included:

- Data must have been validated by a qualified data validator using acceptable data validation methods. Rejected (R) values were not used. Unqualified data and data qualified as J, L, or K were treated as detected. Data qualified as U or B were treated as non-detected.

- For groundwater and surface water, only samples from the most recent 1-year period were considered since these represent the best estimate of current exposures. Data from Geoprobe® sampling and from temporary groundwater wells were not considered.

- Surface soil or sediment data collected prior to any major physical disturbance (such as capping or paving) that would result in the elimination of realistic exposure pathways were not used in the ERA. In addition, surface soil samples that were collected under paved surfaces were also not used in the ERA.

- For surface soil, samples collected from depths of 0 to 6 inches were used since this depth range represents the most realistic potential exposures for most of the ecological receptors evaluated in terrestrial habitats. Although some ecological receptors may be exposed to deeper soils (e.g., down to two feet below the ground surface), no useable data are available for soils in the 6 to 24 inch depth range at SWMUs 1 and 15.

- For sediment, samples from depths of 0 to 6 inches were used preferentially since this depth range represents the most realistic exposures for sediment-dwelling species.

- For surface water and groundwater, total (unfiltered) chemical concentrations were used in the ERA. Dissolved metals data were not collected and therefore are not reported or used in exposure estimation.

The analytical data selected for use in this ERA are provided in Appendix A.

3.3.2 Selection of Receptors

The receptors used in this assessment are the same as those used in the SERA. Upper trophic level receptor species used include:

- Short-tailed shrew - terrestrial mammalian insectivore
- Meadow vole - terrestrial mammalian herbivore
- Deer mouse – terrestrial mammalian omnivore
- Raccoon – semi-aquatic mammalian omnivore
- Mink – semi-aquatic mammalian piscivore
- Red fox - terrestrial mammalian carnivore
- American robin - terrestrial avian insectivore/omnivore
- American kestrel - terrestrial avian insectivore/carnivore
- Great blue heron - terrestrial avian piscivore
- Mallard – wetland/aquatic omnivores
- Marsh wren - wetland/aquatic insectivores
- Freshwater fish
- Amphibians and reptiles

Life history information and exposure parameters for these receptors are summarized in Table 3-5 and discussed in detail in Appendix B. Potential risks to amphibians and reptiles were evaluated using other fauna (birds and mammals) as surrogates, while fish and amphibians (tadpoles) were evaluated through a comparison with surface water and sediment screening values.

Lower trophic level receptor species were evaluated in the ERA based on those taxonomic groupings for which screening values have been developed; these groupings and screening values are used in most ecological risk assessments. As such, specific species of aquatic biota (e.g., macroinvertebrates) were not chosen as receptor species because of the limited information available for specific species and because aquatic biota are dealt with on a community level via a comparison to surface water and sediment screening values. Similarly, terrestrial plants and soil invertebrates (earthworms are the standard surrogate) were evaluated using soil screening values developed specifically for these groups.

3.3.3 Exposure Estimation

Upper trophic level receptor exposures to chemicals present in surface soil, sediment, and surface water were determined by estimating the concentration of each chemical in each relevant dietary component. Incidental ingestion of soil or sediment was included when calculating the total exposure. Since receptors (and their prey) are not exposed directly to chemicals in groundwater, food web exposures were not calculated based on groundwater concentrations. Exposure via drinking water was included in the food web model since each SWMU contains a potential freshwater drinking source.

Only chemicals which were identified as bioaccumulative COPCs in the SERA were evaluated for food web exposures. This list of bioaccumulating chemicals is provided in Table 3-6 and is based on the selection process and approved list documented in CH2M HILL (2000b). In summary, bioaccumulating organic chemicals were defined as those with a maximum reported log K_{ow} value of ≥ 3.0. All of the inorganic chemicals on the Target Analyte List (TAL) were also retained except for the essential macronutrients calcium, magnesium, sodium, and potassium; and cyanide which is readily metabolized and does not bioaccumulate (Eisler 1991). The bioaccumulative compounds include all those recommended in EPA (2000).

Dietary items for which tissue concentrations were modeled included terrestrial plants, soil invertebrates (earthworms), small mammals, aquatic plants, aquatic invertebrates, and fish/frogs. The methodologies used for these tissue calculations are outlined in the following subsection. The uptake of chemicals from the abiotic media into these food items was based (where available) on central tendency estimates (e.g., mean or median) of bioconcentration factors (BCFs) or bioaccumulation factors (BAFs) from the literature. Default factors of 1.0 were used only when data were unavailable for a chemical in the literature.

3.3.3.1 Exposure Point Concentrations

Arithmetic mean media concentrations are used as exposure point concentrations for exposure estimation and food web modeling. Exposure point concentrations for terrestrial and aquatic prey items (plants, soil invertebrates, small mammals, aquatic invertebrates, frogs, and fish) are estimated using bioaccumulation models and mean surface soil or sediment concentrations. The methodology and models used to derive these estimates are described below.

Terrestrial Plants. Tissue concentrations in the above-ground vegetative portion of terrestrial plants were estimated by multiplying the mean measured surface soil concentration for each chemical by chemical-specific soil-to-plant BCFs obtained from the literature. The BCF values used were based on root uptake from soil and on the ratio between dry-weight soil and dry-weight plant tissue. Literature values based on the ratio between dry-weight soil and wet-weight plant tissue were converted to a dry-weight basis by dividing the wet-weight BCF by the estimated solids content for terrestrial plants (15 percent [0.15]; Sample et al. 1997).

For inorganic chemicals without literature based BCFs, a soil-to-plant BCF of 1.0 was assumed. For organic chemicals without literature based BCFs, soil-to-plant BCFs were estimated using the algorithm provided in Travis and Arms (1988):

$$\log B_v = 1.588 - (0.578)(\log K_{ow})$$

where:	B_v	=	Soil-to-plant BCF (unitless; dry weight basis)
	K_{ow}	=	Octanol-water partitioning coefficient (unitless)

The log K_{ow} values used in the calculations were obtained mostly from USEPA (1995b; 1996a) and are listed in Table 3-6. The soil-to-plant BCFs used in this ERA are shown in Table 3-7.

Earthworms. Tissue concentrations in soil invertebrates (earthworms) were estimated by multiplying the mean measured surface soil concentration for each chemical by chemical-specific BCFs or BAFs obtained from the literature. BCFs are calculated by dividing the concentration of a chemical in the tissues of an organism by the concentration of that same chemical in the surrounding environmental medium (in this case, soil) without accounting for uptake via the diet. BAFs consider both direct exposure to soil and exposure via the diet. Since earthworms consume soil, BAFs are more appropriate values and are used in the food web models when available. BAFs based on depurated analyses (soil was purged from the gut of the earthworm prior to analysis) are given preference over undepurated analyses when selecting BAF values since direct ingestion of soil is accounted for separately in the food web model.

The BCF/BAF values used were based on the ratio between dry-weight soil and dry-weight earthworm tissue. Literature values based on the ratio between dry-weight soil and wet-weight earthworm tissue were converted to a dry-weight basis by dividing the wet-weight BCF/BAF by the estimated solids content for earthworms (16 percent [0.16]; USEPA 1993). For chemicals without available measured BAFs or BCFs, an earthworm BAF of 1.0 was assumed. The soil-to-earthworm BCFs/BAFs used in this ERA are shown in Table 3-7.

Small Mammals. Whole-body tissue concentrations in small mammals (shrews, voles, and/or mice) were estimated using one of two methodologies. For chemicals with literature-based soil-to-small mammal BAFs, the small mammal tissue concentration was obtained by multiplying the mean measured surface soil concentration for each chemical by a chemical-specific soil-to-small mammal BAF obtained from the literature. The BAF values used were based on the ratio between dry-weight soil and whole-body dry-weight tissue. Literature values based on the ratio between dry-weight soil and wet-weight tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for small mammals (32 percent [0.32]; USEPA 1993). BAFs for shrews were those reported in Sample et al. (1998b) for insectivores (or for general small mammals if insectivore values were unavailable), for voles were those reported for herbivores, and for mice were those reported for omnivores. The soil-to-small mammal BAFs used in this ERA are shown in Table 3-8.

For chemicals without soil-to-small mammal BAF values, an alternate approach was used to estimate whole-body tissue concentrations. Because most chemical exposure for these small mammal species is via the diet, it was assumed that the concentration of each chemical in the small mammal's tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF (wet-weight basis) of one was assumed. The use of a diet to whole-body BAF of one is likely to result in a conservative estimate of chemical concentrations for chemicals that are not known to biomagnify in terrestrial food chains (e.g., aluminum). For chemicals that are known to biomagnify (e.g., PCBs), a diet to whole-body BAF value of one will likely result in a realistic estimate of tissue concentrations based on reported literature values. For example, a maximum BAF (wet weight) value of 1.0 was reported by Simmons and McKee (1992) for PCBs based on laboratory studies with white-footed mice. Menzie et al. (1992) reported BAF values (wet-weight) for DDT of 0.3 for voles and 0.2 for short-tailed shrews. Reported BAF (wet-weight) values for dioxin were only slightly above one (1.4) for the deer mouse (USEPA 1990). Resulting tissue concentrations (wet-weight) were then converted to dry weight using an estimated solids content of 32 percent (see above).

Aquatic Plants. Tissue concentrations in the above-ground vegetative portion of aquatic plants were estimated using the same methodologies as described above for terrestrial plants except that mean sediment (not soil) concentrations were used in the calculation.

Aquatic Invertebrates. Tissue concentrations in aquatic invertebrates were estimated by multiplying the mean measured sediment concentration for each chemical by chemical-specific sediment-to-invertebrate BAFs obtained from the literature. The BAF values used were based on the ratio between dry-weight sediment and dry-weight invertebrate tissue. BAFs based on depurated analyses (sediment was purged from the gut of the organism prior to analysis) were given preference over undepurated analyses when selecting BAF values since direct ingestion of sediment is accounted for separately in the food web model.

Literature values based on the ratio between dry-weight sediment and wet-weight invertebrate tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for aquatic invertebrates (21 percent [0.21]; USEPA 1993). For chemicals without literature based sediment-to-invertebrate BAFs, a BAF of 1.0 was assumed. The sediment-to-invertebrate BAFs used in the ERA are shown in Table 3-9.

Fish/Frogs. Tissue concentrations in whole-body fish and frogs were estimated by multiplying the mean measured sediment concentration for each chemical by chemical-specific sediment-to-fish BAFs (extrapolated to frogs) obtained from the literature. The BAF values used were based on the ratio between dry-weight sediment and dry-weight fish tissue. Literature values based on the ratio between dry-weight sediment and wet-weight fish tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for fish (25 percent [0.25]; USEPA 1993). For chemicals without literature based sediment-to-fish BAFs, a BAF of 1.0 was assumed. The sediment-to-fish BAFs used in the ERA are shown in Table 3-9.

3.3.3.2 Dietary Intakes

Dietary intakes for each receptor species were calculated using the following formula (modified from USEPA [1993]):

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

where:

where:	DI_x	=	Dietary intake for chemical x (mg chemical/kg body weight/day)
	FIR	=	Food ingestion rate (kg/day, dry-weight)
	FC_{xi}	=	Concentration of chemical x in food item i (mg/kg, dry weight)
	PDF_i	=	Proportion of diet composed of food item i (dry weight basis)
	SC_x	=	Concentration of chemical x in soil/sediment (mg/kg, dry weight)
	PDS	=	Proportion of diet composed of soil/sediment (dry weight basis)
	WIR	=	Water ingestion rate (L/day)
	WC_x	=	Concentration of chemical x in water (mg/L)
	BW	=	Body weight (kg, wet weight)

Receptor-specific values used as inputs to this equation were obtained from Table 3-5. We used averages of values presented in USEPA (1993) when appropriate.

3.4 Risk Calculation

In risk calculation, the exposure concentration (abiotic media) or exposure dose (upper trophic level receptor species) is compared with the corresponding screening values to derive a risk estimate. The outcome of this comparison is a revised list of Chemicals of Potential Concern (COPCs) for each media-pathway-receptor combination evaluated or a conclusion of acceptable risk.

COPCs are selected using the hazard quotient (HQ) method. HQs are calculated by dividing the chemical concentration in the medium being evaluated by the corresponding medium-specific screening value or by dividing the exposure dose by the corresponding ingestion screening value. Chemicals with HQs greater than or equal to 1.0 are considered COPCs.

3.4.1 Fate and Transport Mechanisms

Measured media concentrations reflect the acting fate and transport mechanisms of the chemicals present at each site and provide a direct means to characterize exposure to the abiotic media. The ultimate fate of chemicals in environmental compartments can be estimated from physico-chemical characteristics in the absence of measured values. The physico-chemical characteristics that are most relevant for exposure modeling in this assessment include water solubility, adsorption to solids, octanol-water partitioning, and degradability. These characteristics are defined below. A synthesis of general, non site-specific fate and toxicity information is presented in Appendix C. The information in Appendix C is presented regardless of whether or not it was applicable to the site-specific situations for SWMUs 1 and 15.

The water solubility of a compound influences its partitioning to aqueous media. Highly water soluble constituents, such as some polar volatile organics, have a tendency to remain dissolved in the water column rather than partitioning to soil or sediment (Howard 1991). Compounds with high water solubility also generally exhibit a lower tendency to bioconcentrate in aquatic organisms and a greater likelihood of biodegradation (Howard 1991).

Adsorption is a measure of a compound's affinity for binding to solids, such as soil or sediment particles. Adsorption is expressed in terms of partitioning, either K_d (adsorption coefficient; a unitless expression of the equilibrium concentration in the solid phase versus the water phase) or as K_{oc} (K_d normalized to the organic carbon content of the solid phase; again unitless) (Howard 1991). The higher the K_{oc} or K_d value, the greater the tendency for the constituent to adhere strongly to soil or sediment particles. K_{oc} values can be measured directly or can be estimated from either water solubility or the octanol-water partition coefficient using one of several available regression equations (Howard 1991).

Octanol-water partitioning indicates whether a compound is hydrophilic or hydrophobic. The octanol-water partition coefficient (K_{ow}) expresses the relative partitioning of a compound between octanol (lipids) and water. A high affinity for lipids equates to a high K_{ow} and vice versa. K_{ow} has been shown to correlate well with bioconcentration factors in aquatic organisms, adsorption to soil or sediment particles, and the potential to bioaccumulate in the food chain (Howard 1991). Typically expressed as log K_{ow}, a value of three (3.0) or less generally indicates that the constituent will not bioconcentrate to a significant degree (Maki and Duthie 1978). A log K_{ow} of three equates to an aquatic species bioconcentration factor (BCF) of about 100, using the equation (Lyman et al. 1990):

$$\log BCF = (0.76)\,(\log K_{ow}) - 0.23$$

Degradability is an important factor in determining whether there will be significant loss of mass or change in the form of a constituent over time in the environment. The half-life of a compound is typically used to describe losses from either degradation (biological or abiotic) or from transfer from one compartment to another (e.g., volatilization from soil to air). The half-life is the time required for one-half of the mass of a compound to undergo the loss or degradation process.

As depicted on Figures 4-2 and 5-2, the primary mechanisms for contaminant transport from the source areas at each SWMU are believed to include:

- Leaching of chemicals from the soil and/or waste materials by precipitation and transport by surface runoff to surface water bodies
- Leaching of chemicals from the soil and/or waste materials by infiltrating precipitation and transport to surface water bodies via groundwater
- Uptake by biota from surface soil, sediment, and/or surface water and trophic transfer to upper trophic level receptors

3.4.2 Mechanisms of Toxicity

Mechanisms of toxicity are discussed in the chemical profiles contained in Appendix C.

3.5 Uncertainties

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. The uncertainties associated with this ERA are discussed in Section 6.

4.0 SWMU 1 – West Woods Oil Pit

SWMU 1 is located in the northwestern portion of NAS Oceana, approximately 1,000 feet west of abandoned Runway 9 and the fire fighting training area (Figure 1-1). According to the Initial Assessment Study (IAS), the site was originally an open pit in which an estimated 110,000 gallons of waste oil, fuels (such as JP-5, JP-3, and AVGAS), PD 680, various chlorinated and aromatic hydrocarbons (benzene, toluene, trichlorotrifluoromethane, and naphtha), aircraft-maintenance chemicals, paints, paint thinners and strippers, and agitine were disposed of from the mid-1950s to the late 1960s (RGH 1984). Agitine is a solvent used in cleaning. It contains peraffin, napthene, dipropylene glycol methyl ether, hydrotreated light petroleum distillate, and lanoline. Drilling at this site has also shown that metal, concrete, and other debris were also disposed of in the pit or were included in the fill material. On the basis of a 1958 aerial photograph of the site, the pit appears to have been approximately 50 to 100 feet in diameter.

In 1962, the pit flooded and its contents are believed to have washed into the adjacent stormwater drainage ditch located 100 feet west of the oil disposal pit. As a result, waste disposal ceased and the pit was filled with soil (RGH 1984).

4.1 Summary of the Screening ERA

The COPCs identified in the SERA are summarized in Table 4-1; shaded chemicals are those selected as COPCs based on detected concentrations in one or more media. In groundwater, two organic chemicals (benzo[a]pyrene and napthalene) exceeded their screening values based on maximum detected concentrations. Their HQs were 14.3 and 2.08 respectively. Buchman (1999) recommends the use of a dilution factor of 10 in a SERA to account for the dilution expected during migration and upon discharge of groundwater to surface water in the absence of site-specific dilution factors. If such a dilution factor was applied, only benzo(a)pyrene would be retained. Similarly, the two non-detected COPCs that were retained based on maximum reporting limits (anthracene and hexachloro-butadiene) had HQs of 15 or less, and hexachlorobutadiene would also drop out if a dilution factor of 10 was applied. Of the 18 COPCs retained based on the lack of a screening value, two (pyrene and 1,3,5-trimethylbenzene) were actually detected in groundwater samples.

In surface water, two chemicals (aluminum and iron), both with HQs under seven, were retained as COPCs based on maximum detected concentrations. In surface sediments, one chemical (fluoranthene) was retained as a COPC based on a detected concentration and the maximum HQ was 1.18. In surface soils, seven inorganic chemicals and twelve organic chemicals were retained as COPCs based on detected concentrations. Maximum HQs from food web exposures for metals showed aluminum, iron, and mercury had a NOAEL HQ greater than 10). One SVOC had a NOAEL HQ greater than 1.0 (hexachlorobenzene at 1.29). Maximum HQs for PCBs were elevated, particular for the shrew (over 3,000 for Aroclor 1254).

Assessment endpoints, measurement endpoints, and risk hypotheses are summarized in Table 4-2. The diagrammatic conceptual model is shown in Figure 4-2. Both the conceptual model and endpoints/hypotheses have been modified slightly from the SERA to more appropriately reflect the Step 3A evaluation.

4.2 Environmental Setting

The immediate area around the pit is dominated by shrubs, grass, and herbs. Although forested in the past, the trees have been cut and the site and surrounding areas are now maintained to limit the heights of woody plants due to the proximity to active runways. The eastern perimeter of the SWMU is comprised of mowed and old field grasses and impervious surfaces. Surface drainage flows towards north-south and east-west oriented drainage ditches. The north-south (main) drainage ditch has a permanent flow of surface water to the north. The ditch is approximately 12 to 15 feet wide with steep side slopes about 5 feet high. The ditch generally maintains a low-volume base flow because it is excavated to a depth below the water table during normal precipitation conditions. No vegetation has been observed in the stormwater drainage ditch and the ditch receives maintenance (involving either or both vegetation and sediment removal) to ensure unimpeded stormwater conveyance on an as needed basis. The drainage ditch drains a large part of the NAS and is monitored by the NAS Oceana Environmental Division for stormwater quality as part of the base's Virginia Pollution Discharge Elimination System (VPDES) monitoring program.

A second east-west trending tributary drainage ditch is located south of SWMU 1 and conveys stormwater drainage west into the main drainage ditch. This tributary ditch is perched approximately two feet above the base of the main drainage ditch and is dry except during heavy precipitation events. This ditch contains small shrubs and grass and oxidized, non-saturated soils. It does not provided significant habitat for aquatic life.

SWMU 1 is underlain by silt, sand, and silty sand in three distinct lithologic units that are generally consistent across the site. The uppermost unit is a brown silt or sandy silt that is 4.5 to 6 feet thick. Beneath the silt, an 11- to 13-foot thick clean, fine, to very coarse gray sand extends to a depth of 16 to 19 feet. Underlying the clean gray sand is a third lithologic unit composed of very fine greenish-gray silty sand or sandy silt. The sand in this unit is extremely fine, only slightly coarser than a fine silt.

4.3 Summary of Available Analytical Data

The data used in this ERA were obtained from multiple sources. The 1993 Phase I RCRA Facility Investigation (RFI; CH2M HILL 1993) investigated the extent of soil and groundwater contamination at SWMU 1 and confirmed earlier data on the presence of chemicals in the surface water and sediment of the ditches. Soil analyses have detected volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and low concentrations of pesticides and polychlorinated biphenyls (PCBs). Soil contamination is limited to the center of the SWMU where degraded kerosene is present in soil at the top of the water table. Groundwater analyses have detected low concentrations of metals and BTEX (benzene, toluene, ethylbenzene, and xylenes) in shallow monitoring wells. Low concentrations of trace metals were detected in surface water. Organic and inorganic compounds were largely undetected in sediments. The Phase I RFI recommended that a Corrective Measures Study (CMS) be conducted to evaluate the remedial options for soil and groundwater.

During the CMS (CH2M HILL 1995a), low concentrations of Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAHs) were detected in surface soils; low concentrations of VOCs and PAHs were detected in shallow groundwater; and no contaminants were detected in sediment. Trenching at the site indicated that the degraded kerosene present at the top of the water table in subsurface soil was approximately 0.25 inches thick. The CMS recommended installing two solar-powered free-product skimmers to extract kerosene from select monitoring wells.

Subsequent groundwater sampling activities were conducted at SWMU 1 in October 1998 to support risk assessment work. In November 1998, samples were taken from ten groundwater monitoring wells and five piezometers. Samples were analyzed for Low Concentration VOCs, PAHs, and TPH. Results indicated that the shallow groundwater contains low concentrations of benzene and PAHs (CH2M HILL 1999a).

The SERA (and this ERA) used the nine surface soil samples from the 1995 CMS as these data represent the most recent available data. For groundwater, the ten monitoring wells and five piezometers sampled in November 1998 were used. Surface water and sediment samples collected from four locations (one upgradient of the SWMU) in the main drainage ditch during July 1999 were used. These data are summarized in Tables 4-3 through 4-6 and presented in Appendix A. Figure 4-1 shows the sampling locations.

4.4 Refined Risk Characterization

Refined medium-specific screenings for groundwater, surface water, sediment, and surface soil are presented in Tables 4-3 through 4-6, respectively. Receptor species HQs associated with Step 3A food chain modeling are provided in Table 4-7. Results of the recalculation of risk estimates are discussed by media type below.

4.4.1 Groundwater

Mean chemical concentrations in groundwater (downgradient wells) are compared to surface water screening values in Table 4-3 (maximum concentrations are used if the mean concentration exceeded the maximum). Benzo(a)pyrene exceeded screening values based upon a detected concentration. However, benzo(a)pyrene was detected in one of the 13 samples collected from downgradient wells. Two other chemicals (pyrene and 1,3,5-trimethylbenzene) were detected in groundwater but screening values were not available. Of these three chemicals, only pyrene was detected in surface water samples from the drainage ditch (the presumed discharge point for groundwater; Table 4-4). Pyrene was detected in 8 of 13 samples and the maximum detected concentration was 0.23 ug/l (Table 4-1).

4.4.2 Surface Water

Mean chemical concentrations in surface water (downgradient samples) are compared to screening values in Table 4-4. Only aluminum and iron exceeded screening values based upon a detected concentration and hazard quotients (HQs) were five or less. Three other chemicals (benzo[b]fluoranthene, chrysene, and pyrene) lacking screening values were detected in each of the three surface water samples collected. These detections occurred at concentrations just above the reporting limit.

4.4.3 Sediment

Mean chemical concentrations in sediment (downgradient samples) are compared to screening values in Table 4-5. No chemical exceeded screening values based upon a detected concentration. Twelve chemicals (beryllium and 11 VOCs) lacking screening values were detected in at least one sediment sample. With the exception of beryllium and acetone, these detections occurred at concentrations below the reporting limit.

4.4.4 Surface Soil

Mean chemical concentrations in surface soil are compared to screening values in Table 4-6. The mean concentrations of aluminum (HQ of 240), chromium (HQ of 40), iron (HQ of 44), mercury (HQ of 1.05), and vanadium (HQ of 8.35) exceeded screening values, as did the mean concentrations of seven individual PAHs. HQs for these PAHs were all less than two. However, HQs for total PAHs (based on both the maximum and mean concentration) were less than one (Table 4-6). Four chemicals (one PAH and three VOCs) lacking screening values were detected in at least one surface soil sample.

4.4.5 Food Web Exposures

HQs for the short-tailed shrew (based on NOAELs) exceeded one for aluminum (9.58), iron (2.52), and vanadium (1.14); HQs based on LOAELs were less than one (Table 4-7). Also, HQs (based on NOAELs) for the mink (1.66), marsh wren (5.56), and great blue heron (4.43) exceeded one for iron; HQs based on LOAELs were less than one (Table 4-7).

4.5 Risk Evaluation

The potential for adverse effects associated with the COPCs identified in Section 4.4 and listed in Table 4-8 are evaluated in this section.

4.5.1 Aquatic Habitats

Aquatic habitat on and downgradient of SWMU 1 consists of one drainage ditch, orientated north-south, that is actively maintained as part of the facility's stormwater system. This north-south ditch contains permanent standing/flowing water and may support aquatic species. A second ditch, perpendicular to the north-south ditch, contains no water except during significant rain events and thus does not provide aquatic habitat. Complete transport pathways via surface runoff and groundwater link SWMU 1 to these ditches.

Current transport via groundwater to these ditches appears minimal. Benzo(a)pyrene was the only chemical detected in a downgradient groundwater well that exceeded a screening value. It was only detected in one of 13 downgradient groundwater samples and was not detected in any of the surface water or sediment samples. 1,3,5-trimethylbenzene and pyrene were also detected in downgradient groundwater wells but lacked screening values. 1,3,5-Trimethylbenzene was detected in 2 of 13 downgradient groundwater samples and was not detected in surface water or sediment. Although pyrene was detected in surface water and sediment samples, maximum sediment concentrations did not exceed screening values and pyrene was also detected in upgradient groundwater wells (MW-2 and MW-10; Table 4-9). Therefore, contamination of groundwater does not appear to be a concern at SWMU 1.

Aluminum and iron were the only two chemicals detected in downgradient surface water or sediment samples that exceeded a screening value. HQs (surface water) for both of these metals were 5.52 and 4.01, respectively. A number of chemicals were also detected in downgradient surface water or sediment samples which lacked screening values (Table 4-8). To evaluate the potential significance of these exceedences, and to evaluate those detected chemicals lacking screening values, the downgradient concentrations were compared to concentrations from upgradient surface water and sediment samples (SW-05 and SD-09; Tables 4-10 and 4-11). Sample locations for the upgradient sediment and surface water samples were chosen based upon past sampling information, in order to maximize the possibility of detected concentrations. This ensures that comparisons between the upgradient samples and the downgradient samples were conservative. The comparison with upgradient concentrations (both mean and maximum) is contained in Table 4-12 (surface water) and Table 4-13 (sediment). Maximum concentrations between upgradient and downgradient locations were considered different if the maximum on-site/downgradient concentration exceeded the maximum upgradient concentration by more than 50 percent. A value of 50 percent was used since it represents the range of the standard data quality objectives (DQOs) for accuracy of ±25 percent, resulting in a precision range of 50% (75 to 125 percent of true) of inorganic analytical data (average range of the DQO values for water and soil/sediment) as identified in the Master Project Plans (CH2M HILL 2000d). Since error bounds for surrogate or matrix spike recoveries may be as high as

90 percent before data are assigned a R (rejected) qualifier (USEPA 1992, 1993b, 1994b), a value of 25 percent was considered a reasonable estimate of a true difference between the two concentrations (i.e., represented a level above the acceptable variability in standard analytical methods). A similar comparison was also conducted for mean concentrations.

Based upon this comparison, neither chemical (aluminum and iron) which exceeded its screening value in surface water exceeded upgradient concentrations based on either the mean and maximum (Table 4-12). Although chrysene and pyrene (which lacked surface water screening values) exceeded upgradient surface water concentrations, neither of these chemicals exceeded sediment screening values. Beryllium, 1,1-dichloroethene, acetone, and chloromethane (which lacked sediment screening values) exceeded upgradient sediment concentrations. Beryllium, which is not likely to be site-related based on site history, did not exceed surface water screening values. The three VOCs were not detected in surface water and were present in sediments at concentrations typically near or below reporting limits. Thus, potential risks for surface water and sediment are low to negligible.

Iron was the only chemical that exceeded ingestion-based screening values based on the NOAEL (but not the LOAEL) for aquatic upper trophic level receptors. HQs were five or less for these species based on the NOAEL. HQs were less than one based on LOAELs, suggesting that risks would be low. Considering the conservative exposure estimate assumptions, the likelihood of risk to upper trophic level receptors is negligible.

4.5.2 Terrestrial Habitats

Twelve detected chemicals (aluminum, chromium, iron, mercury, vanadium, and seven PAHs) exceeded surface soil screening values; aluminum, iron, and vanadium also exceeded ingestion-based screening values for terrestrial receptors based on the NOAEL (but not the LOAEL). To evaluate the potential significance of these exceedences, on-site soil concentrations are compared to background surface soil concentrations developed as part of the SWMU 15 Biopile ecological evaluation (CH2M HILL 2000c). Maximum and mean background concentrations were compared to on-site concentrations using the same methodology described in the previous section for upgradient evaluations of surface water and sediment.

Based on this evaluation (Table 4-15), none of the five metals exceeded background surface soil concentrations based on both the mean and maximum. Two of the PAHs exceeded background and 2-methylnaphthalene (no screening value) and indeno[1,2,3-cd]pyrene (HQ = 1.07). Total PAH concentrations (versus concentrations of individual PAHs) did not exceed soil screening values (Table 4-6). As shown in Table 4-6, no single PAH comprised the majority of the total PAH concentration. The contributions of the individual PAHs ranged from 5% to 17% of the total. This suggests that the potential for risks in terrestrial habitats are negligible for all PAHs, with the possible exception of indeno[1,2,3-cd]pyrene which had an HQ of 1.07. This exceedence for indeno[1,2,3-cd]pyrene occurred across about half the individual samples, but the samples were collected to represent most likely impacted areas based upon site history and topographic gradient. Thus this potential exposure would occur across an area about 300 feet by 150 feet.

Three VOCs were detected in surface soils but lacked screening values and background concentrations. Acetone, a common laboratory contaminant which is not considered particularly toxic, was detected at relatively low concentrations in on-site soils (maximum concentration of 20 μg/kg) and is not likely to adversely effect terrestrial fauna at the site. Similarly, 2-butanone and carbon disulfide were detected in one and two of nine samples, respectively, at relatively low concentrations (maximum of 72 and 8 μg/kg, respectively) and are also unlikely to adverse effect terrestrial receptors.

4.5.3 Conclusions

Conclusions drawn from the above analyses are:

Groundwater

- Three SVOCs were detected in groundwater. One SVOC, (benzo(a)pyrene) was detected at levels above the screening value. It was detected in one of thirteen wells and was not detected in any surface water or sediment samples.
- Mean concentrations of napthalene were below the screening value.
- There is not a screening value available for pyrene. Pyrene was detected in eight of thirteen downgradient wells, however, it was also detected in two upgradients wells.
- Only one VOC was detected but lacked a screening value. 1,3,5-Trimethylbenzene was detected within the reporting limit range and in two of thirteen wells. It was not detected in any surface water or sediment samples.

Based upon the above lines of evidence, it is unlikely that COPC concentrations in groundwater pose a site-related ecological risk when discharging into surface water. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 4-1). The potential for risk for such COPCs remains unknown.

Surface Water

- Two detected metals (aluminum and iron) exceeded screening values, both with HQs less than six. Neither metal exceeded upgradient concentrations based on the mean or the maximum concentrations.
- Three SVOCs lacking screening values were detected at concentrations less than reporting limits. Benzo(b)fluoranthene did not exceed upgradient concentrations.
- Chrysene and pyrene exceeded upgradient surface water concentrations. However, neither exceeded sediment screening values.
- All other SVOCs were undetected.
- No pesticides, PCBs, or VOCs were detected in the groundwater.

Based upon the above lines of evidence, it is unlikely that COPC concentrations in surface water pose a site-related ecological risk. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 4-1). The potential for risk for such COPCs remains unknown.

Sediment

- One metal (beryllium and eleven VOCs were detected but lack screening values. Ten of the VOCs were detected at levels below reporting limits.
- Beryllium exceeded exceeded concentrations found in upgradient sediment samples but is not believed to be site-related based on site history.
- Other metals were undetected.
- Only three of the eleven VOCs (1-dichloroethene, acetone, and chloromethane) exceeded concentrations found in upgradient sediment samples. These three were not detected in surface water and the sediment concentrations were near or below reporting limits.

Based upon the above lines of evidence, it is unlikely that COPC concentrations in sediment pose a site-related ecological risk. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 4-1). The potential for risk for such COPCs remains unknown.

Surface Soils

- Five metals had detected concentrations that exceeded screening values in three out of three samples. Concentrations were below background soil levels.
- Seven detected PAHs exceeded screening values; however, HQs were all less than two and the HQ for total PAHs based on both the maximum and mean concentrations were less than one.
- Only two individual PAHs exceeded background soil concentrations, and total PAHs did not exceed background levels
- Three VOCs were detected but lacked screening values. Acetone is a common laboratory contaminant. 2-Butanone and carbon disulfide were detected in one and two samples, respectively, out of nine samples.
- One PAH (2-methylnaphthalene) lacked a screening value and was detected in one of nine of the surface soil samples.
- Exceedences for SVOCs occurred in 1-SS2 (10 exceedences), 1-SS3 (10 exceedences), 1-SS4 (8 exceedences), 1-SS5 (1 exceedence), 1-SS7 (4 exceedences), and OW01-SS09 (11 exceedences). Exceedences for metals occurred in 1-SS1 (5 exceedences) 1-SS2 (6 exceedences), and OW01-SS09 (5 exceedences).

Based on the above lines of evidence and the fact that sampling focused on areas of highest potential contamination (Figure 4-1), it appears that there is an isolated, site-related potential risk to invertebrates in an area approximately 300 feet by 150 feet. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 4-1). The potential for risk for such COPCs remains unknown.

Food Web

- HQs for the short-tailed shrew (based on NOAELs) exceeded one for aluminum (9.58), iron (2.52), and vanadium (1.14). HQs (based on NOAELs) for the mink (1.66), marsh wren (5.56), and great blue heron (4.43) exceeded one for iron
- No HQ for food web exposures exceeded one based on a LOAEL
- Concentrations of aluminum, iron, and vanadium were below background values.

Based upon the lines of evidence above, there is little potential for site-related ecological risk to upper trophic level receptors.

The soil sampling distribution was determined based on the site consistent historical data and information for SWMU 1. The areal extent of contamination at SWMU 1 is limited in size; therefore, the investigation focused on areas of high potential for contamination. Although several COPCs exceeded screening values in surface soil, the detected concentrations of these constituents were generally consistent with the background concentrations. It appears that there is an isolated, site-related potential risk to invertebrates in a localized area (300 by 150 feet) at SWMU 1. Potential risks to aquatic organisms utilizing the drainage ditches are expected to be low to negligible. No COPC exceeded both a screening value and an upgradient concentration in surface water or sediment. Since the concentrations were below background for the chemicals that had NOAEL HQs greater than or equal to one (iron, aluminum, vanadium), the likelihood of risk to upper trophic-level receptors is negligible. As shown in Table 4-1, a number of COPCs resulted from cases where there were no screening values or where detection limits for undetected compounds were above screening values. The potential for risks associated with these chemicals is unknown and represents an uncertainty in the risk assessment. The identified potential for risks to the ecological receptors will be further addressed in the development of remedial alternatives in the feasibility study being drafted for SWMU 1.

5.0 SWMU 15 – Abandoned Tank Farm

SWMU 15 is an abandoned tank farm located in the former North Station area about 800 feet northwest of Runway 23R. SWMU 15 is used to store recreation vehicles near the old CPO officers' club. The abandoned tank farm served as the primary source of aircraft fuel for the North Station area when it was active from the mid-1950s to the mid-1970s. The tank farm consisted of six tanks: (1) a 414,000-gallon tank used to store JP-3, (2) two 50,000-gallon concrete tanks used for aviation gas, and (3) three adjacent 12,000- to 18,000-gallon tanks believed to be used for automotive fuel, kerosene, or lube oil (RGH 1984). The tanks were emptied of fuel and filled with water after they were abandoned (R.E. Wright Associates 1983). Tank G-5 (50,000-gallon capacity) was later used to store waste oil. The tanks and their associated piping were dismantled and removed in the mid-1980s. With the exception of some mounded earth near the former location of Tank G-9, no signs of the locations of the tanks or their associated piping were observed during the Phase I RFI. Their locations were inferred from historical maps and aerial photographs of the North Station area.

5.1 Summary of the Screening ERA

The COPCs identified in the SERA are summarized in Table 5-1; shaded chemicals are those selected as COPCs based on detected concentrations in one or more media. In groundwater, six inorganic and three organic chemicals were retained as COPCs based upon detected concentrations; HQs for all but iron (48.1) and carbon disulfide (97.0) were less than ten. Buchman (1999) recommends the use of a dilution factor of 10 in a SERA to account for the dilution expected during migration and upon discharge of groundwater to surface water in the absence of site-specific dilution factors. If such a dilution factor was applied, only iron and carbon disulfide would be retained as COPCs based on detected concentrations. Similarly, of the thirty-two compounds that were identified as COPCs based on maximum reporting limits, ten would be retained as COPCs if a dilution factor of 10 was applied. Of the twenty-three compounds that were retained as COPCs based on the lack of screening values, only four were actually detected in the groundwater.

For surface water, only aluminum and cyanide were retained as COPCs based on detected concentrations. Both chemicals had HQs of less than three. Concentrations of the twenty-eight compounds that were identified as COPCs for surface water based on maximum reporting limit ranges ranged from 1.08 μg/L to 482 μg/L. Of the 22 compounds that were retained as COPCs for surface water based on the lack of screening values, four were actually detected in surface water samples.

For sediment, only three inorganic chemicals and six organic chemicals were retained as COPCs based on maximum detected concentrations. Of these nine COPCs, all had HQs less than 15 except for acenaphthene which had a HQ of 70.8. Concentrations of the 27 compounds that were identified as COPCs for sediment based on maximum reporting limits ranged from 1.07 μg/kg to 52.7 μg/kg. Only one of the 65 COPCs retained based on the lack of a screening value was detected in sediments.

Maximum HQs for the five metal COPCs in surface soil based on detected concentrations were under 50 except for aluminum which had a HQ of 288. HQs for the SVOC COPCs (all were PAHs) based on detected concentrations ranged from 13.6 to 2,799. The 18 compounds that were identified as COPCs for surface soil based on maximum reporting limits had HQs ranging from 1.86 to 42. Of the 41 compounds that were retained as COPCs for surface soil based on the lack of a screening value, only two were actually detected in surface soils.

For detected chemicals with HQs greater than or equal to one from mean food web exposures, the maximum HQ calculated for mercury was 2.2, for aluminum it was 19.3, for iron it was 21.6, and for vanadium it was 3.3 (Table 5-7).

Assessment endpoints, measurement endpoints, and risk hypotheses are summarized in Table 5-2. The diagrammatic conceptual model is shown in Figure 5-2. Both the conceptual model and endpoints/hypotheses have been modified slightly from the SERA to more appropriately reflect the Step 3A evaluation.

5.2 Environmental Setting

The area around SWMU 15 includes pavement, forests, shrubs, and a man-made pond. Old paved road surfaces and parking lots cover much of the site. A large stand of mature loblolly pine occurs immediately north of the former location of the tanks and mature hardwood stands occur mainly in the eastern half of the site. The shrub communities are located along old field areas and unpaved roadbeds. The area is colonized by an early successional upland herbaceous plant community. This site is underlain by silt and sand in two general units. The first unit consists of silt and slightly sandy silts from the surface to 5 to 7 feet. This is underlain by clean sands and silty sands to at least 16 to 20 feet.

As part of a soil removal action, an area measuring approximately 150 feet by 125 feet was excavated to a depth approximately three feet beneath the water table creating a small open water pond. The excavated material has been biologically treated to minimize contaminant concentrations and have since been used as clean fill elsewhere on the NAS as documented in the SWMU 15 Biopile ecological evaluation (CH2M HILL 2000c). Therefore, the "biopiles" that formerly existed on the site have been removed and are not part of this ERA. In general, drainage from the site is towards the northeast. A shallow drainage ditch crosses the center of the site. No outlet from the ditch has been observed. Water was observed in most of the ditch during a summer 1999 site visit but did not appear to be flowing.

On July 8, 1998, a wetlands scientist with the U.S. Army Corps of Engineers conducted a jurisdictional wetland delineation at SWMU 15. With the exception of the man-made pond, no area within the immediate vicinity of the SWMU was found to meet all three parameters of jurisdictional wetlands (wetland hydrology, hydric soils, and hydrophytic vegetation).

5.3 Summary of Available Analytical Data

The data used in this ERA were obtained from multiple sources as described below. Early investigations of the area included an environmental investigation in 1982, an IAS in 1984, and a RCRA Facility Assessment (RFA) in 1988. The Phase I RFI (CH2M HILL 1993) involved groundwater sampling in order to further investigate contamination at the site. Twelve groundwater samples were taken and analyzed for BTEX and chlorinated solvents. Elevated concentrations of BTEX and low concentrations of chlorinated VOCs were found in the samples. One sample was also analyzed for aromatic volatiles, total and dissolved lead, and PAHs. BTEX, Total Petroleum Volatiles (TPV), and aromatic volatiles, total and dissolved lead, and PAHs were found in the sample for which they were analyzed.

The Phase II RFI (CH2M HILL 1995b) investigation confirmed that the groundwater contained detectable levels of BTEX, chlorinated volatiles, PAHs, TPH, and lead. Fifteen soil samples were taken from areas in the most contaminated areas and were analyzed for VOCs. The samples indicated that petroleum contamination was widespread in the center of the site (the source area).

Soil samples collected from 4 to 6 feet were generally more contaminated than the samples from 1 to 3 feet.

Based on results from a 1996 CMS (CH2M HILL 1996), a soil removal action was conducted at SWMU 15 in 1997 to remediate BTEX contamination in the soil. Approximately 18,000 cubic yards of soil was removed (creating the pond referred to above) and treated on-site through bioremediation and aeration in two biopiles.

Confirmatory subsurface soil samples were also collected around the perimeter of the excavation. Results of perimeter confirmatory sampling indicate that elevated TPH and PAHs are present at a couple of sample locations adjacent to the pond.

In October and November 1998, confirmatory soil samples of treated biopile soil were collected. The Navy removed the upper six feet of biopile soil and staged it for use in the tarmac restoration project. The soil at the base of the biopiles underwent re-treatment to reduce the TPH to a level below the 50 parts per million (ppm) Virginia Department of Environmental Quality (VADEQ) solid waste threshold. The re-treatment was accomplished and the soil re-sampled to confirm that the TPH and BTEX cleanup goals of 50 ppm and 10 ppm, respectively, were achieved (CH2M HILL 1999b). The determination of clean fill from the perspective of ecological risk was determined based upon comparison to screening levels and a documented continued decline in PAH concentrations (CH2M HILL 2000c). Therefore the excavated soils (biopiles) are not considered in this ERA.

The Navy is proposing monitored natural attenuation for the groundwater at this SWMU. In July 1999, the Navy completed a round of groundwater, surface soil, surface water, and sediment sampling to support risk assessment and an assessment of monitored natural attenuation as a remedy for groundwater contamination. The SERA (and this ERA) used the four surface soil, seven groundwater, five surface water, and 16 sediment samples collected during this July 1999 sampling event. These data are summarized in Tables 5-3 through 5-6 and presented in Appendix A. Figure 5-1 shows the sampling locations.

5.4 Refined Risk Characterization

Refined medium-specific screenings for groundwater, surface water, sediment, and surface soil are presented in Tables 5-3 through 5-6, respectively. Receptor species HQs associated with Step 3A food chain modeling are provided in Table 5-7. Results of the recalculation of risk estimates are discussed by media type below.

5.4.1 Groundwater

Mean chemical concentrations in groundwater (downgradient wells) are compared to surface water screening values in Table 5-3 (maximum concentrations are used if the mean concentration exceeded the maximum). Six chemicals (three metals and three VOCs) exceeded screening values based upon a detected concentration. HQs for aluminum, benzene, manganese, and xylenes were 2.5 or less while HQs for iron and carbon disulfide exceeded ten. Four other chemicals (2-methylnaphthalene, chrysene, methane, and pyrene) were detected in groundwater but screening values were not available.

5.4.2 Surface Water

Mean chemical concentrations in surface water are compared to screening values in Table 5-4. Aluminum exceeded screening values based upon a detected concentration and the HQ was 1.48. Four other chemicals (benzo[g,h,i]perylene, chrysene, indeno[1,2,3-cd]pyrene, and pyrene) lacking screening values were detected in surface water samples although chrysene was the only one of these chemicals detected in more than one sample.

5.4.3 Sediment

Mean chemical concentrations in sediment are compared to screening values in Table 5-5. Six chemicals exceeded screening values based upon a detected concentration. HQs were four or less except for acenaphthene (7.83). Three of these chemicals (2-methylnaphthalene, diethylphthalate, and fluorene) exceeded screening values in a single sample. Two chemicals (beryllium and thallium) lacking screening values were detected in at least one sediment sample. The single detection for thallium was within the reporting limit range.

5.4.4 Surface Soil

Mean chemical concentrations in surface soil are compared to screening values in Table 5-6. The mean concentrations of aluminum (HQ of 255), chromium (HQ of 42.9), iron (HQ of 33.4), and vanadium (HQ of 9.06) exceeded screening values in soils. Two PCBs (HQs of 1.27 and 1.20) also exceeded screening values as did 15 PAHs (HQs ranging from 3.85 to 976). Three chemicals (all SVOCs) lacking screening values were detected in at least one surface soil sample.

5.4.5 Food Web Exposures

HQs for the short-tailed shrew (based on NOAELs) exceeded one for aluminum (10.2), iron (1.91), and vanadium (1.24); HQs based on LOAELs were less than one except for aluminum (1.02; Table 5-7). HQs for the raccoon (based on NOAELs) exceeded one for iron (1.98) and vanadium (1.02); HQs based on LOAELs were less than one. HQs for the mink (based on NOAELs) exceeded one for aluminum (6.26), iron (6.43), and vanadium (3.31); HQs based on LOAELs were less than one. HQs for the marsh wren (based on NOAELs) exceeded one for aluminum (1.83) and iron (21.56); HQs based on LOAELs exceeded one for iron (2.16). HQs for the great blue heron (based on NOAELs) exceeded one for aluminum (19.3), iron (17.2), and mercury (2.18); HQs based on LOAELs exceeded one for aluminum (1.93) and iron (1.72).

5.5 Risk Evaluation

The potential for adverse effects associated with the COPCs identified in Section 5.4 and listed in Table 5-8 are evaluated in this section.

5.5.1 Groundwater

Based on contours, groundwater near SWMU 15 appears not to flow directly into the pond but flows southwest and northeast away from the pond (CH2M HILL 2000d). Thus, the on-site pond is not the downgradient receptor for groundwater flow at this SWMU. The actual discharge point for site-related groundwater is not known but no major water bodies occur within at least 0.5 miles of SWMU 15 in the two groundwater flow directions.

Six chemicals (three metals and three VOCs) exceeded screening values based upon a detected concentration in undiluted groundwater samples from downgradient wells. HQs for aluminum, benzene, manganese, and xylenes were 2.5 or less while HQs for iron and carbon disulfide exceeded ten. Four other chemicals (2-methylnaphthalene, chrysene, methane, and pyrene) were detected in groundwater but screening values were not available. Except for methane, maximum concentrations for these four chemicals were below reporting limits.

To evaluate the potential significance of these exceedences, and to evaluate those detected chemicals lacking screening values, the downgradient concentrations were compared to concentrations from upgradient wells (MW-13; Table 5-9). The comparison with upgradient concentrations (both mean and maximum) is contained in Tables 5-10. If the maximum downgradient concentration exceeded the maximum upgradient concentration by more than 50 percent, the exceedence was considered significant. This value of 50 percent is twice the standard data quality objective (DQO) for accuracy and precision of inorganic analytical data; twice the DQO was used since acceptable error bounds for surrogate and spike recoveries are typically higher. Thus, a value of 50 percent was considered a reasonable estimate of a true difference between the two concentrations (i.e., represented a level above the acceptable variability in standard analytical methods). A similar comparison was also conducted for mean concentrations.

Upgradient data were available for only four of the ten groundwater COPCs. Based upon this comparison, manganese appears to be consistent with upgradient concentrations based on mean concentrations. Concentrations of benzene, xylenes, and methane exceeded upgradient concentrations; each of these three chemicals is likely to be site-related based on site history.

Hazard quotients for iron (22.9) and carbon disulfide (16.1) exceeded ten based on the mean concentration (Table 5-8). As discussed above, the comparison of chemical concentrations in groundwater are made directly to surface water screening values and were not adjusted for dilution effects that would occur when groundwater travels from a site and then discharges into a surface water body. Based on the expected dilution when groundwater from the SWMU discharges to a surface water body (which is likely to exceed the recommended dilution factor of 10 in Buchman [1999]), these two chemicals are not expected to have adverse effects to aquatic organisms, especially at the population level, given the magnitude of the observed concentrations. Of the detected chemicals without screening values, only methane was detected at concentrations above reporting limits. A freshwater screening value of 5,500 µg/L is available for chloromethane (USEPA 1999a), a related chemical. Assuming that the toxicity of methane is similar, adverse effects related to this chemical are not expected since the maximum detected concentration in a downgradient well was 3,200 µg/L, well below the screening value.

5.5.2 Aquatic Habitats

Aquatic habitat present within SWMU 15 consists of an artificial pond created when contaminated soils were removed from the SWMU in 1997.

Aluminum was the only chemical detected in surface water that exceeded a screening value; the HQ was 1.48. Four other chemicals (benzo[g,h,i]perylene, chrysene, indeno[1,2,3-cd]pyrene, and pyrene) lacking screening values were detected in surface water samples although chrysene was the only one of these chemicals detected in more than one sample. Except for benzo(g,h,i)perylene, these detections occurred at concentrations near or below the reporting limit. In addition, none of these four PAHs were identified as COPCs in sediment.

Six chemicals exceeded screening values based upon a detected concentration in sediment. HQs were four or less except for acenaphthene (7.83). Three of these six chemicals (2-methylnaphthalene, diethylphthalate, and fluorene) exceeded screening values in only a single sample (sample size varied from 14 to 16) and thus are unlikely to adversely affect ecological receptors. Two chemicals (beryllium and thallium) lacking screening values were detected in at least one sediment sample. There was only a single detection for thallium above the reporting limit. The maximum concentration for beryllium was less than 1 mg/kg and is within background concentrations (CH2M HILL 2000c). Aluminum and iron were the only chemicals that exceeded ingestion-based screening values based on the LOAEL for aquatic upper trophic level receptors. HQs were two or less for these species based on the LOAEL. Considering the conservative exposure estimate assumptions, the likelihood of risk to upper trophic-level receptors is negligible.

5.5.3 Terrestrial Habitats

The mean concentrations of aluminum (HQ of 255), chromium (HQ of 42.9), iron (HQ of 33.4), and vanadium (HQ of 9.06) exceeded screening values in surface soils. Two PCBs (HQs of 1.27 and 1.20) also exceeded screening values as did 15 PAHs (HQs ranging from 3.85 to 976). Three chemicals (all SVOCs) lacking screening values were detected in at least one surface soil sample. Aluminum, iron, and vanadium also exceeded ingestion-based screening values for terrestrial receptors based on the NOAEL (but not the LOAEL except for aluminum [HQ of 1.02]). To evaluate the potential significance of these exceedences, on-site soil concentrations are compared to background surface soil concentrations developed as part of the SWMU 15 Biopile ecological evaluation (CH2M HILL 2000c). Maximum and mean background concentrations were compared to on-site concentrations using the same methodology described in Section 4.5.2 for SWMU 1.

Based on this evaluation (Table 5-11), none of the four metals exceeded background surface soil concentrations based on either the mean or maximum. All of the PAHs substantially exceeded background.

5.5.4 Conclusions

Conclusions drawn from the above analyses are:

Groundwater

- Three detected metals (aluminum, iron, and manganese) exceeded screening values, although two (aluminum and manganese) had HQs less than 2.5.
- Manganese concentrations are consistent with concentrations in upgradient wells.
- Upgradient concentrations were not available for aluminum and iron.
- Three detected VOCs exceeded screening values, although two (benzene and xylene) had HQs less than 2.5. The third (carbon disulfide) had an HQ of 16.1.
- If dilution factors of ten (expected when groundwater discharges to surface water) are applied to iron and carbon disulfide, adverse effects are not expected given the magnitude of the concentrations.
- Benzene and xylene exceeded upgradient groundwater concentrations. Upgradient concentrations for carbon disulfide were not available.
- Three SVOCs and one VOC (methane) were detected but lacked screening values. Maximum concentrations for the SVOCs were all below reporting limits.
- When compared to the screening value for chloromethane (5500 ug/L), a related chemical with similar toxicity, the maximum concentration of methane in a down gradient well (3200 ug/L) was well below the screening value.
- No pesticides or PCBs were detected in groundwater.

Based upon the above lines of evidence, it is unlikely that COPC concentrations in groundwater pose a site-related ecological risk when discharging into surface water. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 5-1). The potential for risk for such COPCs remains unknown.

Surface Water

- One metal exceeded the screening value, however, because the HQs was 1.48, no adverse effects are expected to occur.
- Four SVOCs were detected, however, screening values were lacking. All except chrysene were detected in one sample. All except benzo(g,h,i)perylene had concentrations near or below reporting limits. Only chrysene was detected in more than five samples.
- No pesticides, PCBs, or VOCs were detected in surface water.

Based upon the above lines of evidence, it is unlikely that COPC concentrations in surface water pose a site-related ecological risk. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 5-1). The potential for risk for such COPCs remains unknown.

Sediment

- Six detected chemicals exceeded screening values. Five had HQs below four and the sixth had an HQ below eight.
- Three of these six chemicals (2-methylnaphthalene, diethylphthalate, and fluorene) exceeded screening values in a single sample out of fourteen to sixteen samples).
- Two detected metals (beryllium and thallium) lacked screening values. Thallium was detected in one sample and the concentration was within the reporting limit range.
- No pesticides or PCBs were detected in sediment.

Based upon the above lines of evidence, COPC concentrations in sediments potentially pose a site-related ecological risk to invertebrates in the sediments of the pond. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 5-1). The potential for risk for such COPCs remains unknown.

Surface Soils

- Four detected metals (aluminum, chromium, iron , and vanadium) exceeded screening values, however, none of the four exceeded background soil concentrations based on either maximum or mean concentrations.
- Fifteen PAHs exceeded background soil concentrations.
- Two PCBs exceeded screening values, however, because their HQs were 1.2 and 1.27, no adverse effects are expected to occur.
- Exceedences for SVOCs occurred in OW15-SS06 (22 exceedences), OW15-SS07 (31 exceedences), OW15-SS08 (20 exceedences), and OW15-SS09 (20 exceedences). Exceedences for PCBs occurred in OW15-SS08 (2 exceedences). Exceedences for metals occurred in OW15-SS06 (5 exceedences), OW15-SS07 (5 exceedences), OW15-SS08 (5 exceedences), and OW15-SS09 (6 exceedences).

Based on the above lines of evidence and the fact that sampling focused on areas of highest potential contamination (Figure 5-1), it appears that there is an isolated, site-related potential risk to invertebrates in an area approximately 400 feet by 400 feet. This conclusion is qualified for site-related COPCs for which no screening values were available (see Table 5-1). The potential for risk for such COPCs remains unknown.

Food Web

- HQs for the short-tailed shrew (based on NOAELs) exceeded one for aluminum (10.2), iron (1.91), and vanadium (1.24). HQs based on LOAELs were less than one except for aluminum (1.02; Table 5-7).
- HQs for the raccoon (based on NOAELs) exceeded one for iron (1.98) and vanadium (1.02); HQs based on LOAELs were less than one.
- HQs for the mink (based on NOAELs) exceeded one for aluminum (6.26), iron (6.43), and vanadium (3.31); HQs based on LOAELs were less than one.
- HQs for the marsh wren (based on NOAELs) exceeded one for aluminum (1.83) and iron (21.56); HQs based on LOAELs exceeded one for iron (2.16).
- HQs for the great blue heron (based on NOAELs) exceeded one for aluminum (19.3), iron (17.2), and mercury (2.18); HQs based on LOAELs exceeded one for aluminum (1.93) and iron (1.72).
- Concentrations of aluminum, iron and vanadium were below background levels. There was no background concentration available for mercury.

Based upon the lines of evidence above, there is little potential for site-related ecological risk to upper trophic level receptors.

In conclusion, potential risks to aquatic organisms utilizing SWMU 15 are expected to be low based on the magnitude of the sediment and food web exceedences. The soil sampling distribution was determined based on site consistent historical data and information for SWMU 15. The areal extent of contamination at SWMU 15 is limited in size; therefore, the investigation focused on areas of high potential for contamination. Although several COPCs exceeded screening values in surface soils, the detected concentrations of these constraints were generally consistent with the background concentrations. Potential risks to upper trophic level terrestrial organisms utilizing SWMU 15 are low. Potential risks to lower trophic level terrestrial organisms (e.g., soil invertebrates) exist in the isolated area of the site based on the magnitude of the surface soil exceedences for PAHs. The identified potential for risks to ecological receptors will be further addressed in the development of the redial alternatives in the feasibility study being drafted for SWMU 15.

As shown in Table 5-1, a number of COPCs resulted from cases where there were no screening values or where detection limits for undetected compounds were above screening values. The potential for risks associated with these chemicals is unknown and represents an uncertainty in the risk assessment.

6.0 Uncertainties

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. The uncertainty in this ERA is mainly attributable to the following factors:

- Detection Limits - Detection limits for some analytes exceeded applicable screening values in some media; these COPCs were not further evaluated unless they were detected on the site. However, the ratio of screening values to detection limits was almost always less than 10 in sediment and surface soil, and usually less than 5 in surface water and groundwater (except for PCBs and pesticides, where it ranged from less than one to about 250). The potential for risks associated with these chemicals is unknown and represents an uncertainty in the risk assessment.

- No Screening Values. For some chemicals there were no screening values available for some of the media. This resulted in the chemical being retained as a COPC in the SERA for both detected and undetected chemicals. The potential for risks associated with these chemicals is unknown and represents an uncertainty in the risk assessment.

- Total Versus Dissolved Metals - Current USEPA guidance (USEPA 1996b) indicates that the dissolved metal fraction should be preferentially used to the total metal fraction in surface water screening. Total concentrations were used in the ERA for surface water and groundwater screenings since dissolved data were not available. High levels of suspended solids and sediment-adsorbed metals would result in overstating bioavailable surface water and groundwater concentrations and thus potential exposures and risks.

- Sediment Screening Values - Most of the sediment screening values used in the ERA do not consider site-specific bioavailability to ecological receptors and are typically based on correlational studies (termed the Screening Level Concentration [SLC] approach). These factors tend to make the resulting screening values very conservative and likely overestimate potential risk.

- Evaluation of Groundwater - Although ecological receptors are not directly exposed to groundwater, groundwater concentrations were compared directly to surface water screening values without the application of any dilution factors. Since significant dilution is likely to occur prior to discharge to a surface water body, this procedure results in a very conservative assessment. For illustrative purposes, the implications of applying a dilution factor of 10 (recommended in Buchman [1999]) to the groundwater concentrations were provided in each applicable section.

- Evaluation of Soils - The evaluation of chemical contamination in soils was restricted to surface soils from the 0 to 6 inch depth range. Although some ecological receptors may be exposed to deeper soils (e.g., in the 6 to 24 inch depth range), no useable existing soil data were available from this deeper depth range. However, the evaluation of surface soils in the 0 to 6 inch depth range is likely to result in a conservative assessment since releases were at the surface (and thus higher chemical concentrations would be expected in the surface strata except possibly for volatile organic compounds).

- Ingestion Screening Values - Data on the toxicity of many chemicals to the receptor species were sparse or lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. This is a typical limitation and extrapolation for ecological risk assessments because so few wildlife species have been tested directly for most chemicals. The uncertainties associated with toxicity extrapolation were minimized through the selection of the most appropriate test species for which suitable toxicity data were available. The factors considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet.

A second uncertainty related to the derivation of ingestion screening values applies to metals. Most of the toxicological studies on which the ingestion screening values for metals were based used forms of the metal (such as salts) that have high water solubility and high bioavailability to receptors. Since the analytical samples on which site-specific exposure estimates were based measured total metal concentrations, regardless of form, and these highly bioavailable forms are expected to compose only a fraction of the total metal concentration, this is likely to result in an overestimation of potential risks for these chemicals.

A third source of uncertainty associated with the derivation of ingestion screening values concerns the use of uncertainty factors. For example, NOAELs were extrapolated to LOAELs using an uncertainty factor of ten. This approach is likely to be conservative since Dourson and Stara (1983) determined that 96 percent of the chemicals included in a data review had LOAEL/ NOAEL ratios of five or less. The use of an uncertainty factor of 10, although potentially conservative, also serves to counter some of the uncertainty associated with interspecies extrapolations, for which a specific uncertainty factor was not used.

There are different methods available for converting lab endpoints to actual wildlife endpoints using safety factors. The typical conversion and what was used in this risk assessment is to multiply a NOAEL by ten or an LD50 by 100. Studies have shown that 95% of the cases fall below these conversions (Dourson and Stara 1983). There are other methods that are not necessarily well documented. For example, The TriServices Guideline (which was developed to provide guidance for conducting ERAs for use by risk assessors at U.S. navy, Air Force, and Army installations) proposes a graded scale for laboratory endpoints as well as multipliers of 2 for intraspecific and interspecific applications (Wentzel et al. 1996). However, there is no scientific basis for these multipliers. Use of the latter scheme, would result in HQ's in this risk assessment being increased by a multiple of two to 16. It is unknown whether this increase in robustness of HQs would be better predictors of the actual potential for risk. Using this extra safety factor method could result in having different analytes being retained as COPCs, however, the HQs would be low in general to other chemicals that were COPCs using the scheme used in this risk assessment and would not likely be risk drivers. Using the TriServices scheme would typically result in HQs that are presently between 0.125 and 0.999 being increased to HQs equal to or greater than one (1.0 to 8.0). This would result in those chemicals becoming COPCs. For example, based upon a review of Table 4-7 for SWMU 1, this change would increase the list of COPCs for mammals at SWMU 1 from three COPCs to twelve COPCs.

- <u>Chemical Mixtures</u> - Information on the ecotoxicological effects of chemical interactions is generally lacking, which required (as is standard for ecological risk assessments) that the chemicals be evaluated on a compound-by-compound basis during the comparison to screening value. This could result in an underestimation of risk (if there are additive or synergistic effects among chemicals) or an overestimation of risks (if there are antagonistic effects among chemicals).

- <u>Receptor Species Selection</u> - Reptile and amphibian species were selected as receptors in the ERA, but were not evaluated quantitatively even when exposure pathways to these organisms were likely to be complete for a number of reasons. Reptiles were evaluated using other fauna (birds and mammals) as surrogates due to the general lack of reptile-specific toxicological data. This represents an uncertainty in the risk assessment.

The ERA evaluates amphibians at a critical life stage (tadpole) by screening against ambient water quality criteria or other comparable screening values. After a search of toxicological databases, no dietary toxicological information was found for amphibians. Thus, food web exposures for amphibians were not directly, quantitatively evaluated. However, the ERA analyzed ingestion exposures for other upper trophic level receptors that eat one hundred percent aquatic food items (e.g., raccoon, great blue heron) as well as for receptors that eat one hundred percent terrestrial food items (e.g., short-tailed shrew, meadow vole). By analyzing tadpoles at a sensitive stage and evaluating other (non-amphibian) upper trophic level aquatic and terrestrial receptors, the ERA is likely to adequately bound potential risks to amphibian species, even though they were not quantitatively evaluated.

It was also assumed that any reptiles and amphibians present at the SWMUs were not exposed to significantly higher concentrations of COPCs and were not more sensitive to COPCs than other terrestrial receptor species evaluated in the risk assessment. This assumption was a source of uncertainty in the ERA.

SWMUs 1 and 15 are surrounded by natural habitats, including wet areas, which could support amphibians at all life stages. A drainage ditch occurs adjacent to SWMU 1 that typically is inundated, but there are no permanent, natural surface water bodies adjacent to SWMU 15. No predators were observed in the man-made pond on SWMU 15 or in the drainage ditch adjacent to SWMU 1. Therefore, based on habitat, both sites should support amphibian populations.

In addition, there is some uncertainty associated with the use of specific receptor species to represent larger groups of organisms (e.g., guilds).

- Food Web Exposure Modeling - Chemical concentrations in terrestrial and aquatic food items (plants, earthworms, small mammals, aquatic invertebrates, fish, and frogs) were modeled from measured media concentrations and were not directly measured. The use of generic, literature-derived exposure models and bioaccumulation factors introduces some uncertainty into the resulting estimates. The values selected and methodology employed were intended to provide a reasonable estimate of potential food web exposure concentrations.

  Another source of uncertainty is the use of default assumptions for exposure parameters such as bioconcentration and bioaccumulation factors (BCFs/BAFs). Although BCFs or BAFs for many bioaccumulative chemicals were readily available from the literature and were used in the ERA, the use of a default factor of 1.0 was used for chemicals lacking literature values to estimate the concentration of some chemicals in receptor prey items is a source of uncertainty. However, for most chemicals, the assumption that the chemical body burden in the prey item is at the same concentration as in soil is conservative, particularly when many of the chemicals are known not to accumulate to any significant degree.

Mean Versus Maximum Media Concentrations - As is typical in an ERA, a finite number of samples of environmental media are used to develop the exposure estimates. The most realistic exposure estimates for mobile species with relatively large home ranges and for species populations (even those that are immobile or have limited home ranges) are those based on the mean chemical concentrations in each medium to which these receptors are exposed. This is reflected in the wildlife dietary exposure models contained in the Wildlife Exposure Factors Handbook (USEPA 1993), which specify the use of average media concentrations.

- Selection of log Kow of 3.0 versus 3.5 – The USEPA (2000) recommends that only chemicals for which the log Kow value is less than 3.5 be considered for further evaluation of bioaccumulation potential since chemicals with log Kow values less than 3.5 are not likely to bioaccumulate to a significant degree. For conservatism, a log Kow of 3.0 was used to define a bioaccumulative organic chemical for the purposes of the food web exposure characterization (CH2M HILL 2000b).

7.0 Conclusions

Potential risks to soil invertebrates utilizing SWMU 1 are expected to be low to moderate but occur only in an isolated area. The few COPCs that cause risk in surface soil were generally consistent with background soil concentrations. No COPC exceeded both a screening value and an upgradient concentration in surface water or sediment. No HQ for food web exposures for either terrestrial or aquatic receptors exceeded one based on a LOAEL. Considering the relatively low habitat value of these ditches (which are periodically maintained as part of the stormwater system) and the likelihood that upper trophic level receptors would forage elsewhere (where habitat quality was better) much of the time, risks to these species are likely to be negligible.

Potential risks to aquatic organisms utilizing SWMU 15 are expected to be low based on the magnitude of the sediment and food web exceedences. Potential risks to upper trophic level terrestrial organisms utilizing SWMU 15 are low. Potential risks to lower trophic level terrestrial organisms (e.g., soil invertebrates) are relatively high based on the magnitude of the surface soil exceedences for PAHs, however, they occur in an isolated area.

As shown in Tables 4-1 and 5-1 a number of COPCs resulted from cases where there were no screening values or where detection limits for undetected compounds were above screening values. The potential for risks associated with these chemicals is unknown and represents an uncertainty in the risk assessment.

Based upon the results and the certainty associated with the results, the relative size of these SWMUs, and the proximity of these SWMUs to an active military runway/airfield, site specific toxicity testing or additional sampling on which to base remedial action decisions is not warranted. Therefore, no further study in the risk assessment is recommended at this time. The identified potential for risks to ecological receptors will be further addressed in the remedial alternatives in the feasibility study being drafted for these SWMUs.

8.0 Risk Management

This section represents Step 8 (Risk Management) of the 8 step process of ecological risk assessment. Step 7 (Risk Characterization) is represented above in sections 4.4, 4.5, 5.4, and 5.5 where risks at SWMUs 1 and 15 were determined. Table 8-1 and 8-2 list the chemicals of concern at each SWMU and the receptors that are at risk.

A Draft Feasibility Study (FS) is being prepared to develop remedial action objectives (RAOs) and alternatives for SWMUs 1 and 15. Site-specific remedial alternatives developed in the Draft FS were developed for SWMUs 1 and 15, based upon the results of previous investigations and risk assessments. The site-specific remedial alternatives for SWMU 1 are: (1) Minimize direct contact of human receptors with surface soil that may pose unacceptable risks from residential use of the soil, and (2) prevent unacceptable risks to potential human receptors to the groundwater. The specific remedial alternatives for SWMU 15 are: (1) Minimize direct contact of human receptors with surface soil that may pose unacceptable risks, and (2) prevent unacceptable risks to potential receptors to the groundwater (consumptive and non-consumptive). In order to be protective of ecological health, the Final Feasibility Study will also evaluate the ecological risk as defined in Tables 8-1 and 8-2 and other supporting documentation.

9.0 References

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Table 2-1 Plant Species Known or Expected to Occur *NAS Oceana, Virginia Beach, VA*	
Species	**Common Name**
Trees	
Pinus taeda	Loblolly Pine
Pinus serotina	Pond Pine
Taxodium distichum	Bald Cypress
Chamaecyparis thyoides	Atlantic White Cedar
Juniperus virginiana	Red Cedar
Salix nigra	Black Willow
Populus heterophylla	Swamp Cottonwood
Ostrva virginiana	Hop Hornbeam
Carpinus caroliniana	Musclewood
Fagus grandifolia	American Beech
Quercus alba	White Oak
Quercus lyrata	Overcup Oak
Quercus michauxii	Swamp Chestnut Oak
Quercus fatcata	Southern Red Oak
Quercus falcata var. pagodaefloia	Cherrybark Oak
Quercus nigra	Water Oak
Quercus phellos	Willow Oak
Quercus laurifolia	Laurel Oak
Quercus stellata	Post Oak
Quercus velutina	Black Oak
Liriodendron tulipifera	Yellow Poplar
Magnolia virginiana	Sweetbay
Asimina triloba	Pawpaw
Persea borbonia	Redbay
Sassafras albidum	Sassafras
Liquidambar styraciflua	Sweetgum
Platanus occidentalis	American Sycamore
Crataegus phaenopyrum	Washington Thorn
Amelanchier canadensis	Shadbush
Ilex opaca	American Holly
Acer negundo	Box Elder
Acer rubrum	Red Maple
Scewartia malacodendron	Silky Camellia
Nyssa svlvatica	Black Gum
Nyssa aquatica	Tupelo Gum
Cornus florida	Dogwood
Oxydendrum arboreum	Sourwood
Diospyros virginiana	Persimmon
Symplocos tinctoria	Horse Sugar
Fraxinus caroliniana	Carolina Ash
Fraxinus pennsylvanica	Green Ash
Fraxinus tomentosa	Pumpkin Ash
Prunus serotina	Black Cherry
Shrubs	
Myrica cerifera	Wax Myrtle
Alnus serrulata	Tag Alder
Itea virginica	Virginia Willow

Table 2-1 Plant Species Known or Expected to Occur *NAS Oceana, Virginia Beach, VA*	
Species	**Common Name**
Rosa palustris	Swamp Rose
Sorbus arbutifolia	Red Chokeberry
Rhododendron nudiflorum	Wild Azalea
Rhododendron viscosum	Swamp Azalea
Kalmia angustifolia	Sheep Laurel
Lyonia lingustrina	Male-Berry
Lyonia lucida	Fetter-Bush
Leucothoe axillaris	Dog-Hobble
Leucothoe racemosa	Fetter-Bush
Toxicodenron vernix	Poison Sumac
Rhus copallina	Winged Sumac
Ilex verticillata	Winterberry
Ilex glabra	Inkberry
Ilex coriacea	Sweet Gallberry
Euonymus americanus	Strawberry Bush
Aralia spinosa	Devil's Walking Stick
Clethra alnifolia	Sweet Pepperbush
Vaccinium corymbosum	Righbush Blueberry
Callicarpa americana	French Mulberry
Viburnum nudum	Possumhaw Virburnum
Sambucus canadensis	Elderberry
Cyrilla racemiflora	Titi
Baccharis halmifolia	Groundsel-Tree
Vines	
Smilax hispida	Greenbrier
Smilax rotundifolia	Greenbrier
Sawbrier - Smilax glauca	Greenbrier
Coral Greenbrier - Smilax walteri	Greenbrier
Smilax laurifolia	Greenbrier
Dioscorea villosa	Wild Yac
Clematis crispa	Leather-Flower
Decumaria barbara	Climbing Hydrangea
Toxicodendron radicans	Poison Ivy
Berchemia scandens	Rattan Vine
Parthenocissus quinquefolia	Virginia Creeper
Vitis rotundifolia	Muscadine Grape
Vitis labrusca	Fox Grape
Vitis aestivalis	Summer Grape
Passiflora incarnata	Maypop
Gelsemium sempervirens	Yellow Jessamine
Anisostichus capreolata	Cross Vine
Campsis radicans	Trumpet Vine
Lonicera japonica	Japanese Honeysuckle
Lonicera sempervirens	Coral Honeysuckle
Mikania scandens	Climbing Hempweed

Table 2-1 Plant Species Known or Expected to Occur *NAS Oceana, Virginia Beach, VA*	
Species	**Common Name**
Ferns and Fern Allies	
Lycopodium obscurum	Groundpine
Lycopodium flabelliforme	Running-Pine
Osmunda regalis	Royal Fern
Osmunda cinnamomea	Cinnamon Fern
Lygodium palmatum	Climbing Fern
Dennstaedtia punctilobula	May-scented Fern
Pteridium aquilinum	Bracken Fern
Athyrium asplenioides	Southern Lady Fern
Dryopteris celsa	Log Fern
Dryopteris intermedia	Fancy Fern
Thelypteris noveboracensis	New York Fern
Thelvpteris palustris	Marsh Fern
Onoclea sensibilis	Sensitive Fern
Woodwardia areolata	Netted-Chain Fern
Woodwardia virginica	Virginia Chain Fern
Aeplenium platyneuron	Ebony Spleenwort
Polypodium polypodioides	Resurrection Fern
Herbaceous plants	
Lena valdiviana	Duckweeds
Spirodela oligorrhiza	Duckweeds
Comelina virginica	Dayflower
Trillium pusillum	Dwarf Trillium
Medeola virginiana	Indian Cucumber
Sisyrinchium angustifolium	Blue Eyed Grass
Cypripedium acaule	Pink Lady's Slipper
Listera australis	Southern Twayblade
Goodyera pubescens	Downy Rattlesnake Plantain
Tipularia discolor	Crane Fly Orchid
Saururus cernuus	Lizard's Tail
Boehmeria cylindrica	False Nettle
Phoradendron serotinum	Mistletoe
Tovara virginiana	Jumpseed
Polygonum hydropiperoides	Smartweed
Polygonum pensylvanicum	Knotweed
Phytolacca americana	Pokeweed
Stellaria media	Chickweed
Nuphar luteum	Yellow Pond-Lilly
Clematis viorna	Leather-Flower
Ranunculus species	Buttercups
Cardamine hirsuta	Bitter Cress
Duchesnea indica	Mock Strawberry
Cassia fasciculata	Partridge Pea
Lespedeza cuneata	Lespedeza
Oxalis dillenii	Lady's Sorrel
Geranium carolinianum	Wild Geranium
Impatiens capensis	Jewel-Weed
Hypericum hypericoides	St. John's Wort

Table 2-1
Plant Species Known or Expected to Occur
NAS Oceana, Virginia Beach, VA

Species	Common Name
Hypericum multilum	St. John's Wort
Hypericum virginicum	St. John's Wort
Viola primulifolia	Violet
Decodon verticillatus	Water Loosestrife
Rhexia mariana	Meadow-Beauty
Ludwigia alternifolia	Water Primrose
Ludwigia palustris	Water Primrose
Proserpinaca palustris	Mermaid-Weed
Daucus carota	Queen Anne's Lace
Hydrocotyle umbellata	Marsh Pennywork
Prunella vulgaris	Heal-All
Scutellaria integrifolia	Skullcap
Solanum carolienense	Nightshade
Agalinis purpurea	Gerardia
Conapholis americana	Squaw-Root
Epifagus virginiana	Beech-Drops
Utricularia gibba	Bladderwort
Utricularia purpurea	Purple Bladderwort
Utricularia inflata	Great Bladderwort
Diodia virginiana	Diodia
Mitchella repens	Partridge Berry
Lobelia cardinalis	Cardinal Flower
Achillea millefolium	Yarrow
Ericeron annuus	Daisey Fleabane
Eupatorium capillifolium	Dog-Fennel
Eupatorium coelestinum	Mistflower
Eupatorium maculatum	Joe-Pye-Weed
Solidago erecta	Goldenrod
Taraxacum officinale	Dandelion
Vernonia noveboracensis	Ironweed
Grasses-Sedges-Rushes	
Eriphorum virginicum	Cotton Grass
Scripus cyperinus	Wool Grass
Setaria - species	Foxtail Grasses
Panicum - species	Panic Grasses
Cyperus - species	Sedges
Carex - species	Sedges
Arundinaria gigantea	Switch Cane
Juncus bufonius	Rushes
Juncus repens	Rushes
Source: VA Department of Game and Inland Fisheries - Fish and Wildlife Information System, 1992.	

Table 2-2
Mammal Species Known or Expected to Occur
NAS Oceana, Virginia Beach, VA

Species	Common Name
Eptesicus fuscus	Bat, big brown
Lasiurus intermedius floridanus	Bat, northern yellow
Lasiurus seminolus	Bat, seminole
Castor canadensis	Beaver
Sylvilagus floridanus mallurus	Cottontail, eastern
Odocoileus virginianus	Deer, white-tailed
Urocyon cineroeargenteus	Fox, gray
Synaptomys cooperi helaletes	Lemming, southern bog
Mustela vison mink	Mink, common
Scalopus aquaticus aquaticus	Mole, eastern
Peromyscus leucopus easti	Mouse, Pungo white-footed
Ochrotomys nuttalli nuttalli	Mouse, common golden
Peromyscus leucopus leucopus	Mouse, common white-footed
Peromyscus gossypinus gossypinus	Mouse, cotton
Reithrodontomys humulus humulus	Mouse, eastern harvest
Mus musculus	Mouse, house
Ondatra zibethica	Muskrat
Myocastor coypus	Nutria
Didelphis virginianus	Oppossum
Lutra canadensis lataxina	Otter, river
Sylvilagus palustris palustris	Rabbit, marsh
Procyon lotor lotor	Raccoon
Rattus norvegicus	Rat, Norway
Oryzomys palustris palustris	Rat, marsh rice
Sorex longirostris fisheri	Shrew, Dismal Swamp southeastern
Cryptotis parva parva	Shrew, least
Blarina carolinensis	Shrew, short-tailed
Sorex longirostris longirostris	Shrew, southeastern
Sciurus niger niger	Squirrel, black fox
Scurius carolinensis	Squirrel, eastern gray
Glaucomys volans volans	Squirrel, southern flying
Microtus pinetorum pinetorum	Vole, common pine
Microtus pennsylvanicus	Vole, meadow
Mustela frenata noveboracensis	Weasel, long-tailed

Source: VA Department of Game and Inland Fisheries - Fish and Wildlife Information System, 1992.

Table 2-3
Bird Species Known or Expected to Occur
NAS Oceana, Virginia Beach, VA

Species	Common Name
Botaurus lentiginosus	Bittern, American
Ixobrychus exilis exilis	Bittern, least
Agelaius phoeniceus	Blackbird, red-winged
Sialia sialis	Bluebird, eastern
Colinus virginianus	Bobwhite, northern
Bucephala albeola	Bufflehead
Passerina cyanea	Bunting, indigo
Calamospiza melanocorys	Bunting, lark
Aythya valisineria	Canvasback
Cardinalis cardinalis	Cardinal, northern
Dumetella carolinensis	Catbird, gray
Icteria virens virens	Chat, yellow-breasted
Parus carolinensis	Chickadee, Carolina
Phalacropcorax auritus floridanus	Cormorant, double-crested
Phalacrocorax carbo	Cormorant, great
Molothrus ater	Cowbird, brown-headed
Corvus brachyrhynchos	Crow, American
Corvus ossifragus	Crow, fish
Coccyzus americanus	Cuckoo, yellow-billed
Zenaida macroura carolinensis	Dove, mourning
Columba livia	Dove, rock
Limnodromus scolopaceus	Dowitcher, long-billed
Limnodromus griseus	Dowitcher, short-billed
Anas rubripes	Duck, American black
Oxyura jamaicensis	Duck, ruddy
Aix sponea	Duck, wood
Bubulcus ibis	Egret, cattle
Casmerodius albus egretta	Egret, great
Egretta thula	Egret, snowy
Carpodacus mexicanus	Finch, house
Colaptes auratus	Flicker, northern
Empidonax virescens	Flycatcher, Acadian
Myiarchus crinitus	Flycatcher, great crested
Anas strepera	Gadwall
Polioptila caerulea	Gnatcatcher, blue-gray
Limosa fedoa	Godwit, marbled
Carduelis tristis	Goldfinch, American
Branta canadensis	Goose, Canada
Chen caerulescens atlanticus	Goose, greater snow
Chen caerulescens caerulescens	Goose, lesser snow
Quiscalus major	Grackle, boat-tailed
Quiscalus quiscula	Grackle, common
Podiceps auritus	Grebe, horned
Podilymbus podiceps	Grebe, pied-billed
Podiceps grisegena	Grebe, red-necked
Guiraca caerulea caerulea	Grosbeak, blue
Larus marinus	Gull, great black-backed
Larus argentatus	Gull, herring

Table 2-3 Bird Species Known or Expected to Occur *NAS Oceana, Virginia Beach, VA*	
Species	**Common Name**
Larus atricilla	Gull, laughing
Larus delawarensis	Gull, ring-billed
Buteo lineatus lineatus	Hawk, red-shouldered
Buteo jamaicensis	Hawk, red-tailed
Accipiter striatus velox	Hawk, sharp-shinned
Ardea herodias herodias	Heron, great blue
Butorides striatus verescens	Heron, green-backed
Egretta caerulea caerulea	Heron, little blue
Egretta tricolor	Heron, tricolored
Archilochus colubris	Hummingbird, ruby-throated
Plegadis falcinellus	Ibis, glossy
Cyanocitta cristata	Jay, blue
Junco hyamalis	Junco, dark-eyed
Falco sparverius sparverius	Kestrel, American
Charadrius vociferus	Killdeer
Tyrannus tyrannus	Kingbird, eastern
Ceryle alcyon	Kingfisher, belted
Elanoides forficatus forficatus	Kite, American swallow-tailed
Ictinia mississippiensis	Kite, Mississippi
Calidris canutus rufus	Knot, red
Gavia stellata	Loon, red-throated
Anas platyrhynchos	Mallard
Progne subis	Martin, purple
Sturnella magna	Meadowlark, eastern
Lophodytes cucullatus	Merganser, hooded
Falco columbarius	Merlin
Mimus polyglottos	Mockingbird, northern
Gallinula chloropus cachinnans	Moorhen, common
Nycticorax nycticorax hoactii	Night-heron, black-crowned
Nyctanassa violaceus violaceus	Night-heron, yellow-crowned
Chordeiles minor	Nighthawk, common
Sitta pusilla	Nuthatch, brown-headed
Icterus spurius	Oriole, orchard
Pandion haliaetus carolinensis	Osprey
Seiurus aurocapillus	Ovenbird
Bubo virginianus	Owl, great horned
Contopus virens	Pewee, eastern wood
Sayornis phoebe	Phoebe, eastern
Rallus limicola	Rail, Virginia
Rallus longirostris crepitans	Rail, clapper
Rallus elegans	Rail, king
Turdus migratorius	Robin, American
Calidris alba	Sanderling
Calidris minutilla	Sandpiper, least
Calidris maritima	Sandpiper, purple
Actitis macularia	Sandpiper, spotted
Calidris mauri	Sandpiper, western
Aythya affinis	Scaup, lesser

Table 2-3
Bird Species Known or Expected to Occur
NAS Oceana, Virginia Beach, VA

Species	Common Name
Melanitta nigra americana	Scoter, black
Melanitta perspicillata	Scoter, surf
Melanitta fusca deglandi	Scoter, white-winged
Otus asio	Screech-owl, eastern
Anas clypeata	Shoveler, northern
Rynchops niger	Skimmer, black
Gallinago gallinago	Snipe, common
Spizella passerina	Sparrow, chipping
Spizella pusilla	Sparrow, field
Ammodramus sabannarum pratensis	Sparrow, grasshopper
Passer domesticus	Sparrow, house
Melospiza melodia	Sparrow, song
Sturnus vulgaris	Starling, European
Hirundo rustica	Swallow, barn
Tachycineta bicolor	Swallow, tree
Chaetura pelagica	Swift, chimney
Piranga olivacea	Tanager, scarlet
Piranga rubra	Tanager, summer
Anas discors orphna	Teal, blue-winged
Anas crecca carolinensis	Teal, green-winged
Sterna forsteri	Tern, Forster's
Sterna sandvicensis acuflavidus	Tern, sandwich
Sterna hirundo	Tern, common
Sterna nilotica aranea	Tern, gull-billed
Sterna maxima maximus	Tern, royal
Toxostoma rufum	Thrasher, brown
Hylocichla mustelina	Thrush, wood
Parus bicolor	Titmouse, tufted
Pipilo erythrophthalmus	Towhee, rufous-sided
Arenaria interpres morinella	Turnstone, ruddy
Vireo olivaceus	Vireo, red-eyed
Vireo solitarius	Vireo, solitary
Vireo griseus	Vireo, white-eyed
Vireo flavifrons	Vireo, yellow-throated
Coragyps atratus	Vulture, black
Cathartes aura	Vulture, turkey
Mniotilta varia	Warbler, black-and-white
Wilsonia citrina	Warbler, hooded
Parula americana	Warbler, northern parula
Dendroica palmarum	Warbler, palm
Dendroica pinus	Warbler, pine
Dendroica discolor	Warbler, prairie
Protonotaria citrea	Warbler, prothonotary
Dendroica petechia	Warbler, yellow
Dendroica coronata cornata	Warbler, yellow-rumped
Dendroica dominica	Warbler, yellow-throated
Seiurus motacilla	Waterthrush, Louisiana
Bombycilla cedrorum	Waxwing, cedar

Table 2-3 **Bird Species Known or Expected to Occur** ***NAS Oceana, Virginia Beach, VA***	
Species	**Common Name**
Anas americana	Wigeon, American
Catoptrophorus semipalmatus semipalmatus	Willet
Scolopax minor	Woodcock, American
Picoides pubescans medianus	Woodpecker, downy
Picoides villosus	Woodpecker, hairy
Dryocopus pileatus	Woodpecker, pileated
Melanerpes carolinus	Woodpecker, red-bellied
Melanerpes erythrocephalus	Woodpecker, red-headed
Thryothorus ludovicianus	Wren, Carolina
Troglodytes aedon	Wren, house
Geothlypis trichas brachidactylus	Yellowthroat, common
Source: VA Department of Game and Inland Fisheries - Fish and Wildlife Information System, 1992.	

Table 2-4
Reptile Species Known or Expected to Occur
NAS Oceana, Virginia Beach, VA

Species	Common Name
Chrysemya floridana floridana	Cooter, Florida
Agkistrodon contortrix mokason	Copperhead, northern
Agkistrodon piscivorus piscivorus	Cottonmouth, eastern
Lampropeltis getulus getulus	Kingsnake, eastern
Lampropeltis triangulum elapsoides	Kingsnake, scarlet
Ophisaurus ventralis	Lizard, eastern glass
Ophisaurus attenuatus longicaudus	Lizard, eastern slender glass
Sceloporus undulatus hyacinthinus	Lizard, northern fence
Coluber constrictor constrictor	Racer, northern black
Cnemidophorous sexlineatus	Racerunner, six-lined
Crotalus horridus atricaudatus	Rattlesnake, canebrake
Eumeces laticeps	Skink, broadhead
Eumeces fasciatus	Skink, five-lined
Scincella lateralis	Skink, ground
Eumeces inexpectatus	Skink, southeastern five-lined
Tachemys scripta	Slider, yellowbellied
Elaphe obsoleta obsoleta	Snake, black rat
Nerodia taxispilota	Snake, brown water
Elaphe guttata guttata	Snake, corn
Virginia valeriae	Snake, eastern earth
Thamnophis sirtalis sirtalis	Snake, eastern garter
Heterodon platyrhinos	Snake, eastern hognose
Farancia abacura abacura	Snake, eastern mud
Thamnophis sauritus sauritus	Snake, eastern ribbon
Carphophis amoenus amoenus	Snake, eastern worm
Storeria dekayi dekayi	Snake, northern brown
Storeria occipitomaculata	Snake, northern red-belly
Diadophis punctatus edwardsii	Snake, northern ringneck
Nerodia sipedon sipedon	Snake, northern water
Farancia erytrogramma erytrogramma	Snake, rainbow
Nerodia erythrogaster erythrogaster	Snake, red-belly water
Opheodrys aestivus	Snake, rough green
Cemophora coccinea	Snake, scarlet
Diadophis punctatus punctatus	Snake, southern ringneck
Sternotherus odoratus	Stinkpot
Malaclemys terrapin terrapin	Terrapin, northern diamondback
Chelonia mydas mydas	Turtle, Atlantic green sea
Lepidochelys kempi	Turtle, Kemp's Ridley sea
Chelydra serpentina serpentina	Turtle, common snapping
Terrapene carolina carolina	Turtle, eastern box
Deirochelys reticularia reticularia	Turtle, eastern chicken
Kinosternon subrubrum subrubrum	Turtle, eastern mud
Chrysemys picta picta	Turtle, eastern painted
Eretmochelys imbricata	Turtle, hawksbill sea
Dermochelys coriacea coriacea	Turtle, leatherback sea
Caretta caretta caretta	Turtle, loggerhead sea
Pseudemys rubriventris	Turtle, red-bellied
Clemmys guttata	Turtle, spotted

Source: VA Department of Game and Inland Fisheries - Fish and Wildlife Information System, 1992.

Table 2-5
Amphibian Species Known or Expected to Occur
NAS Oceana, Virginia Beach, VA

Species	Common Name
Amphiuma means	Amphiuma, two-toed
Rana catesbeiana	Bullfrog
Pseudacris brimleyi	Frog, Brimley's chorus
Rana virgatipes	Frog, carpenter
Rana clamitans	Frog, green
Limnaoedus ocularis	Frog, little grass
Rana palustris	Frog, pickeral
Acris gryllus gryllus	Frog, southern cricket
Rana utricularia	Frog, southern leopard
Pseudacris triseriata feriarum	Frog, upland chorus
Notophthalmus viridescens viridescens	Newt, red-spotted
Hyla crucifer crucifer	Peeper, northern spring
Plethodon chlorobryonous	Salamander, Coastal Plain slimy
Pseudotriton montanus montanus	Salamander, eastern mud
Hemidactylium scutatum	Salamander, four-toed
Stereochilus marginatus	Salamander, many-lined
Ambystoma opacum	Salamander, marbled
Desmognathus fuscus fuscus	Salamander, northern dusky
Eurycea bislineata bislineata	Salamander, northern two-lined
Plethodon cinereus	Salamander, redback
Plethodon glutinosus glutinosus	Salamander, slimy
Desmognathus auriculatus	Salamander, southern dusky
Eurycea bislineata cirrigera	Salamander, southern two-lined
Ambystoma maculatum	Salamander, spotted
Eurycea longicauda guttolineata	Salamander, three-lined
Siran lacertina	Siren, greater
Scaphiopus holbrooki holbrooki	Spadefoot, eastern
Bufo woodhousii fowleri	Toad, Fowler's
Gastrophryne carolinensis	Toad, eastern narrowmouth
Bufo terrestris	Toad, southern
Hyla chrysoscelis	Treefrog, Cope's gray
Hyla versicolor	Treefrog, gray
Hyla cinerea	Treefrog, green
Hyla femoralis	Treefrog, pine woods
Hyla squirrela	Treefrog, squirrel
Necturus punctatus	Waterdog, dwarf

Source: VA Department of Game and Inland Fisheries - Fish and Wildlife Information System, 1992.

Table 2-6
Fish Species Known or Expected to Occur
NAS Oceana, Virginia Beach, VA

Species	Common Name
Alosa pseudohazengus	Alewife
Micropterus salmoides	Bass, largemouth
Micropterus dolomieui	Bass, smallmouth
Morono saxatilis	Bass, striped
Morone chrysops	Bass, white
Lepomis macrochirus	Bluegill
Amia calva	Bowfin
Ameiurus nebulosus	Bullhead, brown
Ameiurus natalis	Bullhead, yellow
Cyprinus carpio	Carp, common
Ictalurus punctatus	Catfish, channel
Americus catus	Catfish, white
Pomoxis nigromaculatus	Crappie, black
Clinostomus funduloides	Dace, rosyside
Lepisosteus osseus	Gar, longnose
Fundulus diaphanus	Killifish, banded
Fundulus confluentus	Killifish, marsh
Hybognathus regius	Minnow, eastern silvery
Gambusia affinis	Mosquitofish
Umbra pygmaea	Mudminnow, eastern
Morone americana	Perch, white
Perca flavescens	Perch, yellow
Esox niger	Pickerel, chain
Esox americanus americanus	Pickerel, redfin
Lepomis gibbosus	Pumpkinseed
Dorosoma cepedianum	Shad, gizzard
Dorosoma petenense	Shad, threadfin
Notemigonus crysoleucas	Shiner, golden
Enneacanthus obesus	Sunfish, banded
Enneacanthus gloriosus	Sunfish, bluespotted
Acantharchus pomotis	Sunfish, mud
Lepomis microlophus	Sunfish, redear
Stizostedion vitreum vitreum	Walleye
Lepomis gulosus	Warmouth

Source: VA Department of Game and Inland Fisheries - Fish and Wildlife Information System, 1992.

Table 2-7
Rare Wildlife Known From Virginia Beach and Chesapeake
NAS Oceana, Virginia Beach, VA

Species	Common Name
Stereochilus marginatus	Many-lined salamander
Siren lacertina	Greater Siren
Limnaoedus ocularis	Little Grass Frog
Rana virgatipes	Carpenter Frog
Crotalus horridus atricaudatus	Canebrake rattlesnake
Deirochelys reticularis	Chicken turtle
Ophisaurus ventralis	Eastern glass lizard
Ixobrychus exilis	Least Bittern
Haliaeetus leucocephalus	Bald Eagle
Nycticorax nycticorax	Black-crowned Night Heron
Ardea herodias	Great Blue Heron
Ardea alba	Great Egret
Lophodytes cucullatus	Hooded Merganser
Podilymbus podiceps	Pied-billed Grebe
Picoides borealis	Red-cockaded woodpecker
Actitus macularia	Spotted sandpiper
Limnothlypis swainsonii	Swainson's Warbler
Condylura cristata parva	Star-nosed mole
Blarina brevicauda telmalestes	Dismal Swamp short-tailed shrew
Sorex longirostris fisheri	Dismal Swamp shrew
Synaptomys cooperi helaletes	Southern bog lemming
Plecotus rafinesquii	Rafineque's big-eared bat
Lasiurus seminolis	Seminole bat
Sylvilagus palustris	Marsh rabbit

Source: VA Department of Game and Inland Fisheries - Fish and Wildlife Information System, 1992.

Table 2-8 Rare Plants Known From Virginia Beach and Chesapeake *NAS Oceana, Virginia Beach, VA*
Species
Aster elliotti
Bacopa monnieri
Boltonia caroliniana
Bulbostylis ciliatifolia
Cardamine longii
Carex reniformis
Carex walteriana
Cassia fasciculata
Chamaecyparis thyoides
Cladium jamaicense
Cladium mariscoides
Cuscuta cephalanthii
Cyperus haspan
Desmodium strictum
Dichromena colorata
Drosera intermedia
Eleocharis baldwinii
Eleocharis halophila
Eleocharis radicans
Eleocharis rostellata
Eleocharis vivipara
Erigeron vernus
Eupatorium recurvans
Euphorbia ammannioides
Fimbristylis caroliniana
Galium hispidulum
Heliotropium curassavicum
Hydrocotyle bonariensis
Hypoxis longii
Iresine rhizomatosa
Iva imbricatas
Juncus crassifolius
Juncus elliottii
Juncus megacephalus
Juniperus communis
Kalmia angustifolia
Lechea maritima
Lilaeopsis carolinensis
Limnobium spongia
Lippia nodiflora
Listera australis
Lobelia elongata
Ludwigia alata
Ludwigia Brevipes
Lycopodium inundatum
Nothoscordum bivalve
Nymphoides aquatica
Osmanthus americanus

Table 2-8
Rare Plants Known From Virginia Beach and Chesapeake
NAS Oceana, Virginia Beach, VA

Species
Physalis viscosa
Physostegia leptophylla
Quercus hemisphaerica
Quercus incana
Quercus laevis
Quercus margarettae
Rhynchospora fascicularis
Scirpus acutus
Scirpus etuberculatus
Spiranthes odorata
Stewartia malacodendron
Stipulicida setacea
Tillandsia usneoides
Triglochin striatum
Typha domingensis
Utricularia fibrosa
Utricularia pupurea
Vaccinium macrocarpon
Verbena scabra
Xyris caroliniana
Source: DNH, Technical Report 90-6, 1990.

Table 3-1
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint
Terrestrial Habitats		
Survival, growth, and reproduction of terrestrial soil invertebrate communities.	Are site-retated surface soil concentrations sufficient to adversely effect soil invertebrate communities based on conservative screening values?	Comparison of mean chemical concentrations in surface soil with soil screening values.
Survival, growth, and reproduction of terrestrial plant communities.	Are site-related surface soil concentrations sufficient to adversely effect terrestrial plant communities based on conservative screening values?	Comparison of mean chemical concentrations in surface soil with soil screening values.
Survival, growth, and reproduction of avian terrestrial insectivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.
Survival, growth, and reproduction of avian terrestrial carnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.
Survival, growth, and reproduction of mammalian terrestrial insectivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.
Survival, growth, and reproduction of mammalian terrestrial herbivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume terrestrial plants from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.
Survival, growth, and reproduction of mammalian terrestrial omnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume plants and invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.
Survival, growth, and reproduction of mammalian terrestrial carnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.

Table 3-1
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint
Survival, growth, and reproduction of terrestrial reptiles.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptilian species?	Evidence of potential risk to other upper trophic level terrestrial receptors evaluated in the ERA.
Wetland and Aquatic Habitats		
Survival, growth, and reproduction of benthic invertebrate communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect benthic invertebrate communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.
Survival, growth, and reproduction of aquatic and wetland plant communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect aquatic or wetland plant communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.
Survival, growth, and reproduction of fish communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect fish communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.
Survival, growth, and reproduction of amphibian communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect amphibian communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.
Survival, growth, and reproduction of amphibians.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to amphibian species that may consume aquatic invertebrates from the site?	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA.
Survival, growth, and reproduction of aquatic/wetland reptiles.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to aquatic/wetland reptile species?	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA.
Survival, growth, and reproduction of avian aquatic/wetland insectivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.

Table 3-1
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint
Survival, growth, and reproduction of avian aquatic/wetland omnivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic plants and invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.
Survival, growth, and reproduction of avian aquatic/wetland piscivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.
Survival, growth, and reproduction of mammalian aquatic/wetland piscivores	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.
Survival, growth, and reproduction of mammalian aquatic/wetland omnivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume aquatic/wetland prey from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.

Table 3-2
Medium-Specific Screening Values Used in the ERA
NAS Oceana, Virginia Beach, VA

Chemical	Screening Value	Units	Reference	Hardness (mg/L)	pH	TOC (%)
Surface Water (Fresh)						
1,2-Dibromoethane	180	ug/L	USEPA 1995a (with safety factor of 100)			
4,4'-DDD	0.06	ug/L	USEPA 1995a (with safety factor of 10)			
4,4'-DDT	0.001	ug/L	USEPA 1995a			
4,6-Dinitro-2-methylphenol	2.3	ug/L	USEPA 1999a			
4-Bromophenyl-phenylether	1.5	ug/L	USEPA 1996b			
4-Chloro-3-methylphenol	0.3	ug/L	USEPA 1999a			
Aluminum	87	ug/L	USEPA 1999b			
Anthracene	0.73	ug/L	Suter and Tsao 1996			
Aroclor-1016	0.014	ug/L	USEPA 1995a			
Aroclor-1221	0.28	ug/L	Suter and Tsao 1996			
Aroclor-1232	0.58	ug/L	Suter and Tsao 1996			
Aroclor-1242	0.053	ug/L	Suter and Tsao 1996			
Aroclor-1248	0.081	ug/L	Suter and Tsao 1996			
Aroclor-1254	0.033	ug/L	Suter and Tsao 1996			
Benzene	530	ug/L	USEPA 1995a (with safety factor of 10)			
Benzo(a)pyrene	0.014	ug/L	Suter and Tsao 1996			
Carbon disulfide	2	ug/L	USEPA 1995a			
Chlorobenzene	130	ug/L	USEPA 1996b			
Copper	20.5	ug/L	USEPA 1999b	251.9		
Cyanide	5.2	ug/L	USEPA 1995a			
Dieldrin	0.056	ug/L	USEPA 1999b			
Di-n-octyl phthalate	3	ug/L	Buchman 1999			
Endosulfan I	0.056	ug/L	USEPA 1995a			
Endosulfan II	0.056	ug/L	USEPA 1995a			
Endosulfan sulfate	0.056	ug/L	USEPA 1995a			
Endrin	0.036	ug/L	USEPA 1999b			
Endrin aldehyde	0.036	ug/L	USEPA 1996b			
Endrin ketone	0.036	ug/L	USEPA 1996b			
Heptachlor	0.0069	ug/L	USEPA 1996b			
Heptachlor epoxide	0.0069	ug/L	Suter and Tsao 1996			
Hexachlorobenzene	3.68	ug/L	USEPA 1995a			
Hexachlorobutadiene	9.3	ug/L	USEPA 1995a			

Table 3-2
Medium-Specific Screening Values Used in the ERA
NAS Oceana, Virginia Beach, VA

Chemical	Screening Value	Units	Reference	Hardness (mg/L)	pH	TOC (%)
Hexachlorocyclopentadiene	5.2	ug/L	USEPA 1995a			
Iron	320	ug/L	USEPA 1995a			
Lead	0.80	ug/L	USEPA 1999b	33.8		
Lead	10.3	ug/L	USEPA 1999b	251.9		
Manganese	120	ug/L	Suter and Tsao 1996			
Methoxychlor	0.03	ug/L	USEPA 1995a			
Methyl bromide	110	ug/L	USEPA 1999a			
Naphthalene	100	ug/L	USEPA 1995a			
Pentachlorophenol	15.0	ug/L	USEPA 1999b		7.8	
Silver	0.36	ug/L	Suter and Tsao 1996			
Toxaphene	0.011	ug/L	USEPA 1996b			
Xylene, total	130	ug/L	USEPA 1995a			
Zinc	262	ug/L	USEPA 1999b	251.9		
Sediment						
1,2,4-Trichlorobenzene	40	ug/kg	USEPA 1995a			
1,2-Dichlorobenzene	35	ug/kg	USEPA 1995a			
1,4-Dichlorobenzene	110	ug/kg	USEPA 1995a			
2,4-Dimethylphenol	29	ug/kg	USEPA 1995a			
2-Methylnaphthalene	70	ug/kg	USEPA 1995a			
2-Methylphenol	63	ug/kg	USEPA 1995a			
4,4'-DDE	2.2	ug/kg	USEPA 1995a			
4,4'-DDT	1.58	ug/kg	USEPA 1995a			
Acenaphthene	16	ug/kg	USEPA 1995a			
Acenaphthylene	44	ug/kg	USEPA 1995a			
Aldrin	2	ug/kg	Ontario Ministry of the Environment 1993			
Aluminum	25,500	mg/kg	Buchman 1999			
Anthracene	85.3	ug/kg	USEPA 1995a			
Aroclor-1016	22.7	ug/kg	USEPA 1995a			
Aroclor-1221	22.7	ug/kg	USEPA 1995a			
Aroclor-1232	22.7	ug/kg	USEPA 1995a			
Aroclor-1242	22.7	ug/kg	USEPA 1995a			
Aroclor-1248	22.7	ug/kg	USEPA 1995a			
Aroclor-1254	22.7	ug/kg	USEPA 1995a			

Table 3-2 **Medium-Specific Screening Values Used in the ERA** *NAS Oceana, Virginia Beach, VA*						
Chemical	**Screening Value**	**Units**	**Reference**	**Hardness (mg/L)**	**pH**	**TOC (%)**
Aroclor-1260	22.7	ug/kg	USEPA 1995a			
Benzo(k)fluoranthene	240	ug/kg	Ontario Ministry of the Environment 1993			
Butylbenzylphthalate	63	ug/kg	USEPA 1995a			
Cyanide	0.1	mg/kg	Ontario Ministry of the Environment 1993			
Dibenz(a,h)anthracene	63.4	ug/kg	USEPA 1995a			
Dibenzofuran	540	ug/kg	USEPA 1995a			
Dieldrin	2	ug/kg	Ontario Ministry of the Environment 1993			
Diethylphthalate	200	ug/kg	USEPA 1995a			
Dimethyl phthalate	71	ug/kg	USEPA 1995a			
Endrin	3	ug/kg	Ontario Ministry of the Environment 1993			
Ethylbenzene	10	ug/kg	USEPA 1995a			
Fluoranthene	600	ug/kg	USEPA 1995a			
Fluorene	19	ug/kg	USEPA 1995a			
Heptachlor	0.3	ug/kg	Buchman 1999			
Hexachlorobenzene	22	ug/kg	USEPA 1995a			
Hexachlorobutadiene	11	ug/kg	USEPA 1995a			
Lead	46.7	mg/kg	USEPA 1995a			
n-Nitrosodiphenylamine	28	ug/kg	USEPA 1995a			
PAH (total)	4,022	ug/kg	Long et al. 1995			
Pentachlorophenol	360	ug/kg	USEPA 1995a			
Phenol	420	ug/kg	USEPA 1995a			
Xylene, total	40	ug/kg	USEPA 1995a			
Surface Soil						
1,2,4-Trichlorobenzene	1,270	ug/kg	Efroymson et al. 1997b			
1,2-Dichlorobenzene	100	ug/kg	USEPA 1995a			
1,4-Dichlorobenzene	1,280	ug/kg	Efroymson et al. 1997b			
2,4,5-Trichlorophenol	430	ug/kg	Efroymson et al. 1997a			
2,4,6-Trichlorophenol	580	ug/kg	Efroymson et al. 1997b			
2,4-Dimethylphenol	100	ug/kg	USEPA 1995a			
2-Chloronaphthalene	1,033	ug/kg	MHSPE 1994			2
2-Chlorophenol	100	ug/kg	USEPA 1995a			
2-Methylphenol	100	ug/kg	USEPA 1995a			
4-Methylphenol	100	ug/kg	USEPA 1995a			

Table 3-2
Medium-Specific Screening Values Used in the ERA
NAS Oceana, Virginia Beach, VA

Chemical	Screening Value	Units	Reference	Hardness (mg/L)	pH	TOC (%)
4-Nitrophenol	380	ug/kg	Efroymson et al. 1997b			
Acenaphthene	2,500	ug/kg	Efroymson et al. 1997a			
Acenaphthylene	100	ug/kg	USEPA 1995a			
Aluminum	50	mg/kg	Efroymson et al. 1997a			
Anthracene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Antimony	5	mg/kg	Efroymson et al. 1997a			
Aroclor-1254	100	ug/kg	USEPA 1995a			
Aroclor-1260	100	ug/kg	USEPA 1995a			
Benzo(a)anthracene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Benzo(a)pyrene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Benzo(b)fluoranthene	100	ug/kg	USEPA 1995a			
Benzo(g,h,i)perylene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Benzo(k)fluoranthene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Chloroform	1,000	ug/kg	MHSPE 1994			2
Chromium	0.4	mg/kg	Efroymson et al. 1997b			
Chrysene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Cyanide	0.06	mg/kg	Eisler 1991			
Dibenz(a,h)anthracene	100	ug/kg	USEPA 1995a			
Fluoranthene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Fluorene	1,700	ug/kg	Efroymson et al. 1997b			
Hexachlorocyclopentadiene	1,000	ug/kg	Efroymson et al. 1997a			
Indeno(1,2,3-cd)pyrene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Iron	200	mg/kg	Efroymson et al. 1997b			
Lead	50	mg/kg	Efroymson et al. 1997a			
Mercury	0.1	mg/kg	Efroymson et al. 1997b			
Methylene chloride	1,001	ug/kg	MHSPE 1994			2
Naphthalene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Nitrobenzene	2,260	ug/kg	Efroymson et al. 1997b			
n-Nitrosodiphenylamine	1,090	ug/kg	Efroymson et al. 1997b			
PAH (total)	4,100	ug/kg	MHSPE 1994			2
Pentachlorophenol	3,000	ug/kg	Efroymson et al. 1997a			
Phenanthrene	see PAH, total; 100	ug/kg	MHSPE 1994; USEPA 1995a			
Phenol	1,880	ug/kg	Efroymson et al. 1997b			

Table 3-2 Medium-Specific Screening Values Used in the ERA *NAS Oceana, Virginia Beach, VA*						
Chemical	**Screening Value**	**Units**	**Reference**	**Hardness (mg/L)**	**pH**	**TOC (%)**
Pyrene	100	ug/kg	USEPA 1995a			
Tetrachloroethene	401	ug/kg	MHSPE 1994			2
Vanadium	2	mg/kg	Efroymson et al. 1997a			
Zinc	50	mg/kg	Efroymson et al. 1997a			

Table 3-3
Ingestion Screening Values for Mammals
NAS Oceana, Virginia Beach, VA

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Inorganics								
Aluminum	mouse	0.03	390 days	oral in water	reproduction	193	19.3	ATSDR 1990
Aluminum	dog	10	6 months	oral	reproduction	600	60	ATSDR 1990
Antimony	mouse	0.03	lifetime	oral in water	lifespan/longevity	1.25	0.125	Sample et al. 1996
Arsenic	mouse	0.03	3 generations	oral in water	reproduction	1.26	0.126	Sample et al. 1996
Barium	rat	0.435	16 months	oral in water	growth/hypertension	19.8	5.1	Sample et al. 1996
Cadmium	rat	0.303	6 weeks	oral (gavage)	reproduction	10	1	Sample et al. 1996
Cadmium	dog	10	3 months	oral	reproduction	7.5	0.75	ATSDR 1993
Chromium	rat	0.35	3 months	oral in water	mortality	131.4	13.14	Sample et al. 1996
Cobalt	rat	0.35	69 days	oral in diet	reproduction	50	5	ATSDR 1992a
Iron	rabbit	3.8	?	oral in diet	tolerance level	500	50	NAS 1980
Lead	rat	0.35	3 generations	oral in diet	reproduction	80	8	Sample et al. 1996
Mercury	rat	0.35	3 generations	oral in diet	reproduction	0.16	0.032	Sample et al. 1996
Mercury	mink	1	93 days	oral in diet	mortality/weight loss	0.25	0.15	Sample et al. 1996
Selenium	rat	0.35	1 year	oral in water	reproduction	0.33	0.2	Sample et al. 1996
Thallium	rat	0.365	60 days	oral in water	reproduction	0.74	0.074	Sample et al. 1996
Vanadium	rat	0.26	60 days +	oral intubation	reproduction	2.1	0.21	Sample et al. 1996
Zinc	rat	0.35	GD 1-16	oral in diet	reproduction	320	160	Sample et al. 1996
Zinc	mink	1	25 weeks	oral	reproduction	208	20.8	ATSDR 1992b
Pesticides/PCBs								
4,4'-DDD	rat	0.35	2 years	oral in diet	reproduction	4	0.8	Sample et al. 1996
4,4'-DDD	dog	10	2 generations	oral	reproduction	5	1	ATSDR 1994
4,4'-DDE	rat	0.35	2 years	oral in diet	reproduction	4	0.8	Sample et al. 1996
4,4'-DDE	dog	10	2 generations	oral	reproduction	5	1	ATSDR 1994
4,4'-DDT	rat	0.35	2 years	oral in diet	reproduction	4	0.8	Sample et al. 1996
4,4'-DDT	dog	10	2 generations	oral	reproduction	5	1	ATSDR 1994
Aldrin	rat	0.35	3 generations	oral in diet	reproduction	1	0.2	Sample et al. 1996
Aroclor-1016	mink	1	18 months	oral in diet	reproduction	3.43	1.37	Sample et al. 1996
Aroclor-1221	mink	1	7 months	oral in diet	reproduction	0.69	0.069	Sample et al. 1996
Aroclor-1232	mink	1	7 months	oral in diet	reproduction	0.69	0.069	Sample et al. 1996
Aroclor-1242	mink	1	7 months	oral in diet	reproduction	0.69	0.069	Sample et al. 1996
Aroclor-1248	mouse	0.03	5 weeks	oral in diet	immunological	13	1.3	ATSDR 1995a
Aroclor-1248	rhesus monkey	5	14 months	oral in diet	reproduction	0.1	0.01	Sample et al. 1996
Aroclor-1254	oldfield mouse	0.014	12 months	oral in diet	reproduction	0.68	0.068	Sample et al. 1996
Aroclor-1254	mink	1	4.5 months	oral in diet	reproduction	0.69	0.14	Sample et al. 1996
Aroclor-1260	oldfield mouse	0.014	12 months	oral in diet	reproduction	0.68	0.068	Sample et al. 1996
Aroclor-1260	mink	1	4.5 months	oral in diet	reproduction	0.69	0.14	Sample et al. 1996

Table 3-3
Ingestion Screening Values for Mammals
NAS Oceana, Virginia Beach, VA

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Dieldrin	rat	0.35	3 generations	oral in diet	reproduction	0.2	0.02	Sample et al. 1996
Endrin	mouse	0.03	120 days	oral in diet	reproduction	0.92	0.092	Sample et al. 1996
Endrin Aldehyde	mouse	0.03	120 days	oral in diet	reproduction	0.92	0.092	Sample et al. 1996
Endrin Ketone	mouse	0.03	120 days	oral in diet	reproduction	0.92	0.092	Sample et al. 1996
Heptachlor	mink	1	181 days	oral in diet	reproduction	1	0.1	Sample et al. 1996
Heptachlor Epoxide	mink	1	181 days	oral in diet	reproduction	1	0.1	Sample et al. 1996
Toxaphene	rat	0.35	3 generations	oral in diet	reproduction	80	8	Sample et al. 1996
Semivolatile Organics								
Benzo(a)anthracene	mouse	0.03	GD 7-16	oral (intubation)	reproduction	10	1	Sample et al. 1996
Benzo(a)pyrene	mouse	0.03	GD 7-16	oral (intubation)	reproduction	10	1	Sample et al. 1996
Benzo(b)fluoranthene	mouse	0.03	GD 7-16	oral (intubation)	reproduction	10	1	Sample et al. 1996
Chrysene	mouse	0.03	GD 7-16	oral (intubation)	reproduction	10	1	Sample et al. 1996
Dibenz(a,h)anthracene	mouse	0.03	GD 7-16	oral (intubation)	reproduction	10	1	Sample et al. 1996
Fluorene	mouse	0.03	13 weeks	oral (gavage)	hematological	1250	125	ATSDR 1995b
Hexachlorobenzene	rat	0.35	2 years	oral	reproduction	16	1.6	ATSDR 1989
Pentachlorophenol	rat	0.35	up to 24 months	oral in diet	reproduction	30	3	Coulston and Kolbye 1994

Table 3-4
Ingestion Screening Values for Birds
NAS Oceana, Virginia Beach, VA

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Inorganics								
Aluminum	ringed dove	0.155	4 months	oral in diet	reproduction	1097	109.7	Sample et al. 1996
Antimony	northern bobwhite	0.19	6 weeks	oral	?	47400	4740	Opresko et al. 1993
Arsenic	brown-headed cowbird	0.049	7 months	oral in diet	mortality	7.38	2.46	Sample et al. 1996
Arsenic	mallard	1	128 days	oral in diet	mortality	12.84	5.14	Sample et al. 1996
Barium	chicks	0.121	4 weeks	oral in diet	mortality	417	208	Sample et al. 1996
Cadmium	mallard	1.153	90 days	oral in diet	reproduction	20	1.45	Sample et al. 1996
Chromium	American black duck	1.25	10 months	oral in diet	reproduction	5	1	Sample et al. 1996
Cobalt	chicken	1.8	14 days	oral in diet	growth	14.7	1.47	Diaz et al. 1994
Iron	chicken	1.6	?	oral	maximum tolerance level	1000	100	NAS 1980
Lead	Japanese quail	0.15	12 weeks	oral in diet	reproduction	11.3	1.13	Sample et al. 1996
Lead	American kestrel	0.13	7 months	oral in diet	reproduction	38.5	3.85	Sample et al. 1996
Mercury	Japanese quail	0.15	1 year	oral in diet	reproduction	0.9	0.45	Sample et al. 1996
Mercury	mallard	1	3 generations	oral in diet	reproduction	0.064	0.0064	Sample et al. 1996
Selenium	mallard	1	100 days	oral in diet	reproduction	0.8	0.4	Sample et al. 1996
Selenium	screech owl	0.2	13.7 weeks	oral in diet	reproduction	1.5	0.44	Sample et al. 1996
Thallium	European starling	?	acute	oral	?	3.5	0.35	USEPA 1999c
Vanadium	mallard	1.17	12 weeks	oral in diet	growth/mortality	114	11.4	Sample et al. 1996
Zinc	chicken	1.935	44 weeks	oral in diet	reproduction	131	14.5	Sample et al. 1996
Pesticides/PCBs								
4,4'-DDD	mallard	1.134	chronic	oral	reproduction	5.2	0.52	Stickel 1973
4,4'-DDD	American kestrel	0.115	2 years	oral	reproduction	0.5	0.05	McLane and Hall 1972
4,4'-DDE	brown pelican	3.5	chronic	oral	reproduction	1.31	0.131	Beyer et al. 1996
4,4'-DDE	American kestrel	0.115	2 years	oral	reproduction	0.5	0.05	McLane and Hall 1972
4,4'-DDT	mallard	1.134	chronic	oral	reproduction	1.04	0.104	Davison and Sell 1974
4,4'-DDT	American kestrel	0.115	2 years	oral	reproduction	0.5	0.05	McLane and Hall 1972
Aldrin	mallard	1.134	chronic	oral	mortality	5	0.5	Tucker and Crabtree 1970
Aroclor-1016	screech owl	0.181	2 generations	oral in diet	reproduction	4.1	0.41	Sample et al. 1996
Aroclor-1221	screech owl	0.181	2 generations	oral in diet	reproduction	4.1	0.41	Sample et al. 1996
Aroclor-1232	screech owl	0.181	2 generations	oral in diet	reproduction	4.1	0.41	Sample et al. 1996
Aroclor-1242	screech owl	0.181	2 generations	oral in diet	reproduction	4.1	0.41	Sample et al. 1996
Aroclor-1248	ring-necked pheasant	1	17 weeks	oral	reproduction	1.8	0.18	Sample et al. 1996
Aroclor-1254	ring-necked pheasant	1	17 weeks	oral	reproduction	1.8	0.18	Sample et al. 1996
Aroclor-1260	ring-necked pheasant	1	17 weeks	oral	reproduction	1.8	0.18	Sample et al. 1996
Dieldrin	barn owl	0.466	2 years	oral in diet	reproduction	0.77	0.077	Sample et al. 1996
Endrin	mallard	1.15	>200 days	oral in diet	reproduction	3	0.3	Sample et al. 1996
Endrin	screech owl	0.181	>83 days	oral in diet	reproduction	0.1	0.01	Sample et al. 1996

Table 3-4 Ingestion Screening Values for Birds *NAS Oceana, Virginia Beach, VA*								
Chemical	**Test Organism**	**Body Weight (kg)**	**Duration**	**Exposure Route**	**Effect/Endpoint**	**LOAEL (mg/kg/d)**	**NOAEL (mg/kg/d)**	**Reference**
Endrin Aldehyde	mallard	1.15	>200 days	oral in diet	reproduction	3	0.3	Sample et al. 1996
Endrin Aldehyde	screech owl	0.181	>83 days	oral in diet	reproduction	0.1	0.01	Sample et al. 1996
Endrin Ketone	mallard	1.15	>200 days	oral in diet	reproduction	3	0.3	Sample et al. 1996
Endrin Ketone	screech owl	0.181	>83 days	oral in diet	reproduction	0.1	0.01	Sample et al. 1996
Heptachlor	quail	0.191	5 days	oral in diet	mortality	4.05	0.405	Hill et al. 1975
Heptachlor Epoxide	quail	0.191	5 days	oral in diet	mortality	4.05	0.405	Hill et al. 1975
Toxaphene	mallard	1.043	5 days	oral in diet	mortality	3.07	0.307	Hill and Camardese 1986
Semivolatile Organics								
Benzo(a)anthracene	chicken	1.5	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Benzo(a)pyrene	chicken	1.5	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Benzo(b)fluoranthene	chicken	1.5	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Chrysene	chicken	1.5	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Dibenz(a,h)anthracene	chicken	1.5	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Fluorene	chicken	1.5	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Hexachlorobenzene	Japanese quail	0.19	?	oral	reproduction	0.8	0.08	Coulston and Kolbye 1994
Pentachlorophenol	chicken	1.5	8 weeks	oral	growth	200	100	Eisler 1989

Table 3-5
Exposure Parameters for Upper Trophic Level Ecological Receptors
NAS Oceana, Virginia Beach, VA

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)	
	Value	Reference	Value	Reference	Value	Reference
Birds						
American kestrel	0.114	USEPA 1993	0.01377	allometric equation	0.00882	USEPA 1993
American robin	0.0773	USEPA 1993	0.01062	allometric equation	0.00552	Levey and Karasov 1989
Great blue heron	2.23	Quinney 1982	0.10098	allometric equation	0.39306	allometric equation
Mallard	1.177	Bellrose 1980	0.06581	allometric equation	0.06471	allometric equation
Marsh wren	0.01125	Dunning 1993	0.00292	allometric equation	0.00249	USEPA 1993
Mammals						
Deer mouse	0.0168	Silva and Downing 1995	0.00302	USEPA 1993	0.00051	USEPA 1993
Meadow vole	0.0428	Silva and Downing 1995	0.00899	USEPA 1993	0.00209	USEPA 1993
Mink	0.777	Silva and Downing 1995	0.02176	USEPA 1993	0.02587	USEPA 1993
Raccoon	5.94	Silva and Downing 1995	0.49209	allometric equation	0.10003	Conover 1989
Red fox	4.06	Silva and Downing 1995	0.34939	allometric equation	0.12308	Sample and Suter 1994
Short-tailed shrew	0.01687	USEPA 1993	0.00376	USEPA 1993	0.00149	USEPA 1993

Table 3-5 Exposure Parameters for Upper Trophic Level Ecological Receptors *NAS Oceana, Virginia Beach, VA*									
	Dietary Composition (percent)							Soil/ Sediment Ingestion (percent)	
Receptor	Terr. Plants	Soil Invert.	Small Mammals	Fish/ Frogs	Aquatic Plants	Aquatic Invert.	Reference	Value	Reference
Birds									
American kestrel	0	38	60	0	0	0	USEPA 1993	2	Assumed based on diet
American robin	51.6	43.6	0	0	0	0	Martin et al. 1951	4.8	Sample and Suter 1994
Great blue heron	0	0	0	100	0	0	USEPA 1993; Quinney and Smith 1980	0	Sample and Suter 1994
Mallard	0	0	0	0	86.7	10	Palmer 1976	3.3	Beyer et al. 1994
Marsh wren	0	0	0	0	0	95	USEPA 1993	5	Assumed based on diet
Mammals									
Deer mouse	53	45	0	0	0	0	Martin et al. 1951	2	Beyer et al. 1994
Meadow vole	95.6	2	0	0	0	0	USEPA 1993	2.4	Beyer et al. 1994
Mink	0	0	0	94	1	5	USEPA 1993	0	Sample and Suter 1994
Raccoon	0	0	0	7	40	43.6	USEPA 1993	9.4	Beyer et al. 1994
Red fox	7	2.8	87.4	0	0	0	USEPA 1993	2.8	Beyer et al. 1994
Short-tailed shrew	4.7	82.3	0	0	0	0	USEPA 1993; Sample and Suter 1994	13	Sample and Suter 1994

Table 3-6
Bioaccumulative Chemicals List and Log K_{ow} Values
NAS Oceana, Virginia Beach, VA

Chemical	Log K_{ow} Range	Selected log K_{ow}	Reference	Evaluate for Food Web Exposures?
Volatile Organics				
1,1,1-Trichloroethane	2.47 to 2.51	2.48	USEPA 1995b	NO
1,1,2,2-Tetrachloroethane	2.31 to 2.64	2.39	USEPA 1995b	NO
1,1,2-Trichloroethane	2.03 to 2.07	2.05	USEPA 1995b	NO
1,1-Dichloroethane	1.78 to 1.85	1.79	USEPA 1995b	NO
1,1-Dichloroethene	2.13 to 2.37	2.13	USEPA 1995b	NO
1,2-Dibromo-3-Chloropropane	2.26 to 2.41	2.34	USEPA 1995b	NO
1,2-Dibromoethane	Not reported	2.00	USEPA 1996a	NO
1,2-Dichloroethane	1.40 to 1.48	1.47	USEPA 1995b	NO
1,2-Dichloropropane	1.94 to 1.99	1.97	USEPA 1995b	NO
2-Butanone	0.26 to 0.69	0.28	USEPA 1995b	NO
2-Hexanone	Not reported	1.40	USEPA 1996a	NO
4-Methyl-2-Pentanone	1.17 to 1.25	1.19	USEPA 1995b	NO
Acetone	-0.21 to -0.24	-0.24	USEPA 1995b	NO
Benzene	1.83 to 2.50	2.13	USEPA 1995b	NO
Bromochloromethane	Not reported	1.41	SRC 1998	NO
Bromodichloromethane	1.88 to 2.14	2.10	USEPA 1995b	NO
Bromoform	2.30 to 2.38	2.35	USEPA 1995b	NO
Bromomethane	1.08 to 1.19	1.19	USEPA 1995b	NO
Carbon disulfide	1.84 to 2.16	2.00	USEPA 1995b	NO
Carbon tetrachloride	2.03 to 3.10	2.73	USEPA 1995b	YES
Chlorobenzene	2.46 to 3.79	2.86	USEPA 1995b	YES
Chloroethane	Not reported	1.43	USEPA 1996a	NO
Chloroform	1.81 to 3.04	1.92	USEPA 1995b	YES
Chloromethane	0.90 to 0.94	0.91	USEPA 1995b	NO
Cis-1,2-Dichloroethene	1.77 to 2.10	1.86	USEPA 1995b	NO
Cis-1,3-Dichloropropene	1.76 to 2.10	2.00	USEPA 1995b	NO

Table 3-6 Bioaccumulative Chemicals List and Log K_{ow} Values *NAS Oceana, Virginia Beach, VA*				
Chemical	**Log K_{ow} Range**	**Selected log K_{ow}**	**Reference**	**Evaluate for Food Web Exposures?**
Dibromochloromethane	2.13 to 2.24	2.17	USEPA 1995b	NO
Ethylbenzene	3.07 to 3.57	3.14	USEPA 1995b	YES
Methylene chloride	1.22 to 1.40	1.25	USEPA 1995b	NO
Styrene	2.76 to 3.16	2.94	USEPA 1995b	YES
Tetrachloroethene	2.53 to 3.70	2.67	USEPA 1995b	YES
Toluene	2.21 to 3.13	2.75	USEPA 1995b	YES
Trans-1,2-Dichloroethene	1.77 to 2.10	2.07	USEPA 1995b	NO
Trans-1,3-Dichloropropene	1.76 to 2.10	2.00	USEPA 1995b	NO
Trichloroethene	2.53 to 3.14	2.71	USEPA 1995b	YES
Vinyl chloride	1.23 to 1.52	1.50	USEPA 1995b	NO
Xylenes (total)	2.77 to 3.68	3.20	USEPA 1995b	YES
Semivolatile Organics				
1,2,4-Trichlorobenzene	3.89 to 4.23	4.01	USEPA 1995b	YES
1,2-Dichlorobenzene	3.20 to 3.61	3.43	USEPA 1995b	YES
1,3-Dichlorobenzene	Not reported	3.50	USEPA 1996a	YES
1,4-Dichlorobenzene	3.26 to 3.78	3.42	USEPA 1995b	YES
2,2'-Oxybis(1-Chloropropane)	Not reported	2.50	USEPA 1996a	NO
2,4,5-Trichlorophenol	2.39 to 4.19	3.90	USEPA 1995b	YES
2,4,6-Trichlorophenol	3.29 to 4.05	3.70	USEPA 1995b	YES
2,4-Dichlorophenol	2.80 to 3.30	3.08	USEPA 1995b	YES
2,4-Dimethylphenol	1.99 to 2.49	2.36	USEPA 1995b	NO
2,4-Dinitrophenol	1.40 to 1.79	1.55	USEPA 1995b	NO
2,4-Dinitrotoluene	1.98 to 2.05	2.01	USEPA 1995b	NO
2,6-Dinitrotoluene	1.72 to 2.03	1.87	USEPA 1995b	NO
2-Chloronaphthalene	Not reported	4.10	USEPA 1996a	YES
2-Chlorophenol	0.83 to 2.32	2.15	USEPA 1995b	NO
2-Methylnaphthalene	Not reported	3.90	USEPA 1996a	YES

Table 3-6
Bioaccumulative Chemicals List and Log K_{ow} Values
NAS Oceana, Virginia Beach, VA

Chemical	Log K_{ow} Range	Selected log K_{ow}	Reference	Evaluate for Food Web Exposures?
2-Methylphenol	1.90 to 2.04	1.99	USEPA 1995b	NO
2-Nitroaniline	Not reported	1.90	USEPA 1996a	NO
2-Nitrophenol	Not reported	1.80	USEPA 1996a	NO
3,3'-Dichlorobenzidine	3.51 to 3.95	3.51	USEPA 1995b	YES
3-Nitroaniline	Not reported	1.40	USEPA 1996a	NO
4,6-Dinitro-2-Methylphenol	Not reported	2.10	USEPA 1996a	NO
4-Bromophenyl-Phenylether	4.89 to 5.24	5.00	USEPA 1995b	YES
4-Chloro-3-Methylphenol	Not reported	3.10	USEPA 1996a	YES
4-Chloroaniline	1.57 to 2.02	1.85	USEPA 1995b	NO
4-Chlorophenyl-Phenylether	4.08 to 5.09	4.95	USEPA 1995b	YES
4-Methylphenol	1.38 to 2.04	1.95	USEPA 1995b	NO
4-Nitroanaline	Not reported	1.40	USEPA 1996a	NO
4-Nitrophenol	Not reported	1.90	USEPA 1996a	NO
Acenaphthene	3.77 to 4.49	3.92	USEPA 1995b	YES
Acenaphthylene	Not reported	4.10	USEPA 1996a	YES
Anthracene	3.45 to 4.80	4.55	USEPA 1995b	YES
Benzo(a)anthracene	4.00 to 5.79	5.70	USEPA 1995b	YES
Benzo(a)pyrene	5.98 to 6.42	6.11	USEPA 1995b	YES
Benzo(b)fluoranthene	5.79 to 6.40	6.20	USEPA 1995b	YES
Benzo(g,h,i)perylene	6.63 to 7.05	6.70	USEPA 1995b	YES
Benzo(k)fluoranthene	6.12 to 6.27	6.20	USEPA 1995b	YES
Bis-(2-Chloroethoxy)methane	Not reported	0.75	USEPA 1996a	NO
Bis-(2-Chloroethyl)ether	1.00 to 1.29	1.21	USEPA 1995b	NO
Bis-(2-Ethylhexyl)phthalate	4.20 to 8.61	7.30	USEPA 1995b	YES
Butylbenzylphthalate	3.57 to 5.02	4.84	USEPA 1995b	YES
Carbazole	3.01 to 3.76	3.59	USEPA 1995b	YES
Chrysene	5.41 to 5.79	5.70	USEPA 1995b	YES

Table 3-6
Bioaccumulative Chemicals List and Log K_{ow} Values
NAS Oceana, Virginia Beach, VA

Chemical	Log K_{ow} Range	Selected log K_{ow}	Reference	Evaluate for Food Web Exposures?
Dibenz(a,h)anthracene	6.50 to 6.88	6.69	USEPA 1995b	YES
Dibenzofuran	Not reported	4.20	USEPA 1996a	YES
Diethylphthalate	1.40 to 3.00	2.50	USEPA 1995b	YES
Dimethylphthalate	1.34 to 1.90	1.57	USEPA 1995b	NO
Di-n-butylphthalate	3.74 to 4.79	4.61	USEPA 1995b	YES
Di-n-octylphthalate	8.03 to 9.49	8.06	USEPA 1995b	YES
Fluoranthene	4.31 to 5.39	5.12	USEPA 1995b	YES
Fluorene	4.04 to 4.40	4.21	USEPA 1995b	YES
Hexachloro-1,3-butadiene	4.74 to 5.16	4.81	USEPA 1995b	YES
Hexachlorobenzene	5.00 to 7.42	5.89	USEPA 1995b	YES
Hexachlorocyclopentadiene	5.04 to 5.51	5.39	USEPA 1995b	YES
Hexachloroethane	3.82 to 4.14	4.00	USEPA 1995b	YES
Indeno(1,2,3-cd)pyrene	6.58 to 6.72	6.65	USEPA 1995b	YES
Isophorone	1.67 to 1.90	1.70	USEPA 1995b	NO
Naphthalene	3.01 to 4.70	3.36	USEPA 1995b	YES
Nitrobenzene	1.70 to 2.93	1.84	USEPA 1995b	NO
N-Nitrosodi-n-propylamine	1.31 to 1.49	1.40	USEPA 1995b	NO
N-Nitrosodiphenylamine	3.13 to 3.45	3.16	USEPA 1995b	YES
Pentachlorophenol	3.29 to 5.24	5.09	USEPA 1995b	YES
Phenanthrene	4.28 to 4.57	4.55	USEPA 1995b	YES
Phenol	0.79 to 1.55	1.48	USEPA 1995b	NO
Pyrene	4.76 to 5.52	5.11	USEPA 1995b	YES
Pesticides/PCBs				
4,4'-DDD	4.73 to 6.65	6.10	USEPA 1995b	YES
4,4'-DDE	5.63 to 6.96	6.76	USEPA 1995b	YES
4,4'-DDT	3.98 to 7.01	6.53	USEPA 1995b	YES
Aldrin	5.11 to 7.50	6.50	USEPA 1995b	YES

Table 3-6 Bioaccumulative Chemicals List and Log K_{ow} Values *NAS Oceana, Virginia Beach, VA*				
Chemical	**Log K_{ow} Range**	**Selected log K_{ow}**	**Reference**	**Evaluate for Food Web Exposures?**
Alpha-BHC	3.75 to 3.81	3.80	USEPA 1995b	YES
Alpha-Chlordane	5.80 to 6.41	6.32	USEPA 1995b	YES
Aroclor-1016	Not reported	5.60	Sample et al. 1996	YES
Aroclor-1221	Not reported	4.70	Jones et al. 1997	YES
Aroclor-1232	Not reported	5.10	Jones et al. 1997	YES
Aroclor-1242	Not reported	5.60	Jones et al. 1997	YES
Aroclor-1248	Not reported	6.20	Jones et al. 1997	YES
Aroclor-1254	Not reported	6.50	Jones et al. 1997	YES
Aroclor-1260	Not reported	6.80	Jones et al. 1997	YES
Beta-BHC	3.75 to 3.84	3.81	USEPA 1995b	YES
Delta-BHC	Not reported	4.10	USEPA 1996a	YES
Dieldrin	3.63 to 6.20	5.37	USEPA 1995b	YES
Endosulfan I	3.83 to 3.85	3.83	USEPA 1995b	YES
Endosulfan II	4.45 to 4.52	4.52	USEPA 1995b	YES
Endosulfan sulfate	Not reported	3.70	USEPA 1996a	YES
Endrin	2.92 to 5.20	5.06	USEPA 1995b	YES
Endrin aldehyde	--	4.00	USEPA 1995b	YES
Endrin ketone	--	4.00	Endrin aldehyde	YES
Gamma-BHC (Lindane)	3.00 to 4.95	3.73	USEPA 1995b	YES
Gamma-Chlordane	5.80 to 6.41	6.32	USEPA 1995b	YES
Heptachlor	4.93 to 6.26	6.26	USEPA 1995b	YES
Heptachlor epoxide	3.50 to 5.40	5.00	USEPA 1995b	YES
Methoxychlor	3.31 to 5.60	5.08	USEPA 1995b	YES
Toxaphene	3.23 to 5.56	5.50	USEPA 1995b	YES
PCBs (total)	Not reported	6.00	USEPA 1996a	YES
Inorganics				
Aluminum	--	--	--	YES

Table 3-6
Bioaccumulative Chemicals List and Log K_{ow} Values
NAS Oceana, Virginia Beach, VA

Chemical	Log K_{ow} Range	Selected log K_{ow}	Reference	Evaluate for Food Web Exposures?
Antimony	--	--	--	YES
Arsenic	--	--	--	YES
Barium	--	--	--	YES
Beryllium	--	--	--	YES
Cadmium	--	--	--	YES
Calcium	--	--	--	NO
Chromium	--	--	--	YES
Cobalt	--	--	--	YES
Copper	--	--	--	YES
Cyanide	--	--	--	NO
Iron	--	--	--	YES
Lead	--	--	--	YES
Magnesium	--	--	--	NO
Manganese	--	--	--	YES
Mercury	--	--	--	YES
Nickel	--	--	--	YES
Potassium	--	--	--	NO
Selenium	--	--	--	YES
Silver	--	--	--	YES
Sodium	--	--	--	NO
Thallium	--	--	--	YES
Vanadium	--	--	--	YES
Zinc	--	--	--	YES

Table 3-7
Soil Bioconcentration Factors Used For Plants and Soil Invertebrates
NAS Oceana, Virginia Beach, VA

Chemical	Soil-Plant BCF (dry weight)		Soil-Invertebrate BAF (dry weight)	
	Value	Reference	Value	Reference
Metals				
Aluminum	0.004	Baes et al. 1984	0.053	Sample et al. 1998a
Antimony	0.2	Baes et al. 1984	0.063	Helmke et al. 1979
Arsenic	0.0371	Bechtel Jacobs 1998a	0.258	Sample et al. 1998a
Barium	0.15	Baes et al. 1984	0.36	Beyer and Stafford 1993
Cadmium	0.514	Bechtel Jacobs 1998a	7.66	Sample et al. 1998a
Chromium	0.0075	Baes et al. 1984	0.32	Sample et al. 1998a
Cobalt	0.02	Baes et al. 1984	0.38	Helmke et al. 1979
Iron	0.004	Baes et al. 1984	0.038	Sample et al. 1998a
Lead	0.0377	Bechtel Jacobs 1998a	0.307	Sample et al. 1998a
Mercury	0.344	Bechtel Jacobs 1998a	1.186	Sample et al. 1998a
Selenium	0.567	Bechtel Jacobs 1998a	0.982	Sample et al. 1998a
Thallium	0.004	Baes et al. 1984	1	--
Vanadium	0.0055	Baes et al. 1984	0.039	Sample et al. 1998a
Zinc	0.358	Bechtel Jacobs 1998a	2.482	Sample et al. 1998a
Pesticides/PCBs				
4,4'-DDD	0.0115	Travis and Arms 1988	2	Menzie et al. 1992
4,4'-DDE	0.0048	Travis and Arms 1988	10.6	Menzie et al. 1992
4,4'-DDT	0.0065	Travis and Arms 1988	0.7	Menzie et al. 1992
Aldrin	0.0068	Travis and Arms 1988	1	--
Aroclor-1016	0.0224	Travis and Arms 1988	4.297	Sample et al. 1998a
Aroclor-1221	0.0744	Travis and Arms 1988	4.297	Sample et al. 1998a
Aroclor-1232	0.0437	Travis and Arms 1988	4.297	Sample et al. 1998a
Aroclor-1242	0.0224	Travis and Arms 1988	4.297	Sample et al. 1998a
Aroclor-1248	0.0101	Travis and Arms 1988	4.297	Sample et al. 1998a
Aroclor-1254	0.0068	Travis and Arms 1988	4.297	Sample et al. 1998a
Aroclor-1260	0.0045	Travis and Arms 1988	4.297	Sample et al. 1998a
Dieldrin	0.0305	Travis and Arms 1988	8	Beyer and Gish 1980
Endrin	0.0461	Travis and Arms 1988	1	--
Endrin Aldehyde	0.1888	Travis and Arms 1988	1	--
Endrin Ketone	0.1888	Travis and Arms 1988	1	--
Heptachlor	0.0093	Travis and Arms 1988	10	Roberts and Dorough 1985

Table 3-7
Soil Bioconcentration Factors Used For Plants and Soil Invertebrates
NAS Oceana, Virginia Beach, VA

Chemical	Soil-Plant BCF (dry weight)		Soil-Invertebrate BAF (dry weight)	
	Value	Reference	Value	Reference
Heptachlor Epoxide	0.0499	Travis and Arms 1988	10	Roberts and Dorough 1985
Toxaphene	0.0256	Travis and Arms 1988	1	--
Semivolatile Organics				
Benzo(a)anthracene	0.0197	Travis and Arms 1988	0.27	Beyer and Stafford 1993
Benzo(a)pyrene	0.0114	Travis and Arms 1988	0.34	Beyer and Stafford 1993
Benzo(b)fluoranthene	0.0101	Travis and Arms 1988	0.21	Beyer and Stafford 1993
Chrysene	0.0197	Travis and Arms 1988	0.44	Beyer and Stafford 1993
Dibenz(a,h)anthracene	0.0053	Travis and Arms 1988	0.49	Beyer and Stafford 1993
Fluorene	0.1428	Travis and Arms 1988	0.2	Beyer and Stafford 1993
Hexachlorobenzene	0.0153	Travis and Arms 1988	1.69	Beyer 1996
Pentachlorophenol	0.0443	Travis and Arms 1988	5.18	van Gestel and Ma 1988

Table 3-8
Soil Bioaccumulation Factors Used For Small Mammals
NAS Oceana, Virginia Beach, VA

Chemical	Soil-Mouse BAF (dry weight)		Soil-Vole BAF (dry weight)		Soil-Shrew BAF (dry weight)	
	Value	Reference	Value	Reference	Value	Reference
Metals						
Aluminum	--	see text	--	see text	--	see text
Antimony	--	see text	--	see text	--	see text
Arsenic	0.0033	Sample et al. 1998b	0.0054	Sample et al. 1998b	0.0039	Sample et al. 1998b
Barium	0.0451	Sample et al. 1998b	0.0689	Sample et al. 1998b	0.0548	Sample et al. 1998b
Cadmium	0.144	Sample et al. 1998b	0.134	Sample et al. 1998b	2.212	Sample et al. 1998b
Chromium	0.092	Sample et al. 1998b	0.1249	Sample et al. 1998b	0.0939	Sample et al. 1998b
Cobalt	0.0168	Sample et al. 1998b	0.0315	Sample et al. 1998b	0.0251	Sample et al. 1998b
Iron	0.0121	Sample et al. 1998b	0.0137	Sample et al. 1998b	0.013	Sample et al. 1998b
Lead	0.0548	Sample et al. 1998b	0.0406	Sample et al. 1998b	0.1478	Sample et al. 1998b
Mercury	0.0731	Sample et al. 1998b	0.0672	Sample et al. 1998b	0.0672	Sample et al. 1998b
Selenium	0.2579	Sample et al. 1998b	0.0221	Sample et al. 1998b	0.273	Sample et al. 1998b
Thallium	0.1124	Sample et al. 1998b	0.1124	Sample et al. 1998b	0.1124	Sample et al. 1998b
Vanadium	--	see text	--	see text	--	see text
Zinc	0.5092	Sample et al. 1998b	0.2929	Sample et al. 1998b	0.862	Sample et al. 1998b
Pesticides/PCBs						
4,4'-DDD	--	see text	--	see text	--	see text
4,4'-DDE	--	see text	--	see text	--	see text
4,4'-DDT	--	see text	--	see text	--	see text
Aldrin	--	see text	--	see text	--	see text
Aroclor-1016	--	see text	--	see text	--	see text
Aroclor-1221	--	see text	--	see text	--	see text
Aroclor-1232	--	see text	--	see text	--	see text
Aroclor-1242	--	see text	--	see text	--	see text
Aroclor-1248	--	see text	--	see text	--	see text
Aroclor-1254	--	see text	--	see text	--	see text
Aroclor-1260	--	see text	--	see text	--	see text
Dieldrin	--	see text	--	see text	--	see text
Endrin	--	see text	--	see text	--	see text
Endrin Aldehyde	--	see text	--	see text	--	see text
Endrin Ketone	--	see text	--	see text	--	see text
Heptachlor	--	see text	--	see text	--	see text

Table 3-8 **Soil Bioaccumulation Factors Used For Small Mammals** ***NAS Oceana, Virginia Beach, VA***						
Chemical	**Soil-Mouse BAF (dry weight)**		**Soil-Vole BAF (dry weight)**		**Soil-Shrew BAF (dry weight)**	
	Value	**Reference**	**Value**	**Reference**	**Value**	**Reference**
Heptachlor Epoxide	--	see text	--	see text	--	see text
Toxaphene	--	see text	--	see text	--	see text
Semivolatile Organics						
Benzo(a)anthracene	--	see text	--	see text	--	see text
Benzo(a)pyrene	--	see text	--	see text	--	see text
Benzo(b)fluoranthene	--	see text	--	see text	--	see text
Chrysene	--	see text	--	see text	--	see text
Dibenz(a,h)anthracene	--	see text	--	see text	--	see text
Fluorene	--	see text	--	see text	--	see text
Hexachlorobenzene	--	see text	--	see text	--	see text
Pentachlorophenol	--	see text	--	see text	--	see text

Table 3-9
Sediment Bioaccumulation Factors Used For Aquatic Invertebrates and Fish/Frogs
NAS Oceana, Virginia Beach, VA

Chemical	Sediment-Invertebrate BAF (dry weight)		Sediment-Fish/Frog BAF (dry weight)	
	Value	Reference	Value	Reference
Metals				
Aluminum	0.027	Brumbaugh et al. 1994; Ingersoll et al. 1994	1	--
Antimony	1	--	1	--
Arsenic	0.437	Bechtel Jacobs 1998b	0.126	Pascoe et al. 1996
Barium	1	--	1	--
Cadmium	0.679	Bechtel Jacobs 1998b	0.164	Pascoe et al. 1996
Chromium	0.09	Bechtel Jacobs 1998b	0.038	Krantzberg and Boyd 1992
Cobalt	1	--	1	--
Iron	1	--	1	--
Lead	0.338	Bechtel Jacobs 1998b	0.07	Krantzberg and Boyd 1992
Mercury	1.022	Bechtel Jacobs 1998b	3.25	Cope et al. 1990
Selenium	1	--	1	--
Thallium	1	--	1	--
Vanadium	1	--	1	--
Zinc	0.954	Bechtel Jacobs 1998b	0.147	Pascoe et al. 1996
Pesticides/PCBs				
4,4'-DDD	0.5	Oliver 1987	1.66	Oliver and Niimi 1988
4,4'-DDE	4.3	Oliver 1987	15.88	Oliver and Niimi 1988
4,4'-DDT	0.5	Oliver 1987	6.56	Oliver and Niimi 1988
Aldrin	1	--	1	--
Aroclor-1016	1.92	Bechtel Jacobs 1998b	8.64	Oliver and Niimi 1988
Aroclor-1221	1.92	Bechtel Jacobs 1998b	8.64	Oliver and Niimi 1988
Aroclor-1232	1.92	Bechtel Jacobs 1998b	8.64	Oliver and Niimi 1988
Aroclor-1242	1.92	Bechtel Jacobs 1998b	8.64	Oliver and Niimi 1988
Aroclor-1248	1.92	Bechtel Jacobs 1998b	8.64	Oliver and Niimi 1988
Aroclor-1254	1.92	Bechtel Jacobs 1998b	8.64	Oliver and Niimi 1988
Aroclor-1260	1.92	Bechtel Jacobs 1998b	8.64	Oliver and Niimi 1988
Dieldrin	1	--	1	--
Endrin	1	--	1	--
Endrin Aldehyde	1	--	1	--
Endrin Ketone	1	--	1	--
Heptachlor	1	--	1	--

Table 3-9 **Sediment Bioaccumulation Factors Used For Aquatic Invertebrates and Fish/Frogs** ***NAS Oceana, Virginia Beach, VA***				
	Sediment-Invertebrate BAF (dry weight)		**Sediment-Fish/Frog BAF (dry weight)**	
Chemical	**Value**	**Reference**	**Value**	**Reference**
Heptachlor Epoxide	1	--	1	--
Toxaphene	1	--	1	--
Semivolatile Organics				
Benzo(a)anthracene	0.358	Maruya et al. 1997	1	--
Benzo(a)pyrene	0.127	Maruya et al. 1997	1	--
Benzo(b)fluoranthene	0.15	Maruya et al. 1997	1	--
Chrysene	0.198	Maruya et al. 1997	1	--
Dibenz(a,h)anthracene	1	--	1	--
Fluorene	0.481	Maruya et al. 1997	1	--
Hexachlorobenzene	1	--	1	--
Pentachlorophenol	1	--	1	--

Table 4-1
Summary of COPCs from the Screening ERA - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
Inorganics															
Aluminum				X						X			X		
Antimony										X			X		
Arsenic													X		
Beryllium									X						
Cadmium													X		
Chromium										X			X		
Cyanide								X			X				
Iron				X						X			X		
Lead					X								X		
Mercury										X			X		
Selenium													X		
Silver					X										
Thallium									X					X	
Vanadium										X			X		
Zinc										X			X		
Pesticides/Polychlorinated Biphenyls															
4,4'-DDD					X									X	
4,4'-DDE								X					X		
4,4'-DDT					X			X						X	
Aldrin								X						X	
Aroclor-1016					X			X						X	
Aroclor-1221					X			X						X	
Aroclor-1232					X			X						X	
Aroclor-1242					X			X						X	
Aroclor-1248					X			X						X	
Aroclor-1254					X			X		X			X		
Aroclor-1260								X						X	
delta-BHC									X						
Dieldrin					X			X						X	
Endosulfan I					X				X			X			
Endosulfan II					X				X			X			

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 4-1
Summary of COPCs from the Screening ERA - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
Endosulfan sulfate					X				X			X			
Endrin					X			X						X	
Endrin aldehyde					X				X					X	
Endrin ketone					X				X					X	
Heptachlor					X			X				X		X	
Heptachlor epoxide					X									X	
Methoxychlor					X				X						
Toxaphene					X				X			X		X	
Semivolatile Organic Compounds															
1,2,3-Trichlorobenzene			X												
1,2,4-Trichlorobenzene								X			X				
1,2-Dichlorobenzene								X			X				
1,3-Dichlorobenzene									X			X			
1,4-Dichlorobenzene								X							
2,2'-Oxybis(1-chloropropane)						X			X			X			
2,4,5-Trichlorophenol									X		X				
2,4,6-Trichlorophenol									X						
2,4-Dichlorophenol									X						
2,4-Dimethylphenol								X			X				
2,4-Dinitrophenol									X						
2,4-Dinitrotoluene									X			X			
2,6-Dinitrotoluene						X			X			X			
2-Chloronaphthalene									X						
2-Chlorophenol									X		X				
2-Methylnaphthalene						X		X				X			
2-Methylphenol								X			X				
2-Nitroaniline						X			X			X			
2-Nitrophenol									X			X			
3,3'-Dichlorobenzidine						X			X			X			
3-Nitroaniline						X			X			X			
4,6-Dinitro-2-methylphenol					X				X			X			
4-Bromophenyl-phenylether					X				X			X			

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 4-1
Summary of COPCs from the Screening ERA - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
4-Chloro-3-methylphenol					X				X			X			
4-Chloroaniline									X			X			
4-Chlorophenyl-phenylether						X			X			X			
4-Methylphenol						X					X				
4-Nitroaniline						X			X			X			
4-Nitrophenol									X		X				
Acenaphthene								X							
Acenaphthylene			X			X		X			X				
Anthracene		X						X							
Benzo(a)anthracene										X					
Benzo(a)pyrene	X				X					X					
Benzo(b)fluoranthene			X			X				X					
Benzo(g,h,i)perylene			X			X				X					
Benzo(k)fluoranthene			X			X		X		X					
Butylbenzylphthalate								X				X			
Carbazole						X			X			X			
Chrysene			X			X				X					
Di-n-octyl phthalate					X							X			
Dibenz(a,h)anthracene			X			X		X			X				
Dibenzofuran												X			
Dimethyl phthalate								X							
Fluoranthene							X			X					
Fluorene								X							
Hexachlorobenzene					X			X				X		X	
Hexachlorobutadiene		X			X			X				X			
Hexachlorocyclopentadiene					X				X						
Hexachloroethane									X			X			
Indeno(1,2,3-cd)pyrene			X			X				X					
Isophorone									X			X			
Naphthalene	X									X					
Nitrobenzene									X						
Pentachlorophenol					X			X							

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 4-1
Summary of COPCs from the Screening ERA - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
Phenanthrene										X					
Phenol								X							
Pyrene			X			X				X					
bis(2-Chloroethoxy)methane									X			X			
bis(2-Chloroethyl)ether									X			X			
bis(2-Ethylhexyl)phthalate												X			
n-Nitroso-di-n-propylamine						X			X			X			
n-Nitrosodiphenylamine								X							
Volatile Organic Compounds															
1,1,2,2-Tetrachloroethane									X						
1,1-Dichloroethane									X						
1,1-Dichloroethene									X			X			
1,1-Dichloropropene			X												
1,2,4-Trimethylbenzene			X												
1,3,5-Trimethylbenzene			X												
1,2,3-Trichloropropane			X												
1,2-Dibromo-3-chloropropane						X									
1,2-Dichloroethane									X						
1,2-Dichloropropane									X						
1,2-Dichloroethene (total)									X						
1,3-Dichloropropane			X												
2,2-Dichloropropane			X												
2-Butanone									X			X			
2-Hexanone									X			X			
4-Methyl-2-pentanone									X						
Acetone									X			X			
Benzene									X						
Bromobenzene			X												
Bromodichloromethane									X						
Bromoform									X						
Bromomethane									X			X			
Carbon disulfide									X			X			

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 4-1
Summary of COPCs from the Screening ERA - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
Carbon tetrachloride									X						
Chlorobenzene									X						
Chloroethane			X			X			X			X			
Chloroform									X		X				
Chloromethane									X			X			
Dibromochloromethane									X			X			
Ethylbenzene								X							
Methylene chloride									X		X				
Styrene			X			X			X						
Tetrachloroetene											X				
Toluene									X						
Vinyl chloride									X						
cis-1,3-Dichloropropene									X						
trans-1,3-Dichloropropene									X						

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 4-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 1
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Terrestrial Habitats			
Survival, growth, and reproduction of terrestrial soil invertebrate communities.	Are site-related surface soil concentrations sufficient to adversely effect soil invertebrate communities based on conservative screening values?	Comparison of mean chemical concentrations in surface soil with soil screening values.	Soil Invertebrates (earthworms)
Survival, growth, and reproduction of terrestrial plant communities.	Are site-related surface soil concentrations sufficient to adversely effect terrestrial plant communities based on conservative screening values?	Comparison of mean chemical concentrations in surface soil with soil screening values.	Terrestrial plants
Survival, growth, and reproduction of avian terrestrial insectivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	American robin
Survival, growth, and reproduction of avian terrestrial carnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	American kestrel
Survival, growth, and reproduction of mammalian terrestrial insectivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Short-tailed shrew
Survival, growth, and reproduction of mammalian terrestrial omnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume terrestrial plants and invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Deer Mouse

Table 4-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 1
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of mammalian terrestrial herbivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume terrestrial plants from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Meadow vole
Survival, growth, and reproduction of mammalian terrestrial carnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Red fox
Survival, growth, and reproduction of terrestrial reptiles.	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptile species?	Evidence of potential risk to other upper trophic level terrestrial receptors evaluated in the ERA.	--
Wetland and Aquatic Habitats			
Survival, growth, and reproduction of benthic invertebrate communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect benthic invertebrate communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Benthic invertebrates
Survival, growth, and reproduction of aquatic and wetland plant communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect aquatic or wetland plant communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Aquatic/wetland plants
Survival, growth, and reproduction of fish communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect fish communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Freshwater fish

Table 4-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 1
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of amphibian communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect amphibian communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Amphibians
Survival, growth, and reproduction of amphibians.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to amphibian species that may consume aquatic invertebrates from the site?	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA.	--
Survival, growth, and reproduction of aquatic/wetland reptiles.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to aquatic/wetland reptile species?	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA.	--
Survival, growth, and reproduction of avian aquatic/wetland insectivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Marsh wren
Survival, growth, and reproduction of avian aquatic/wetland omnivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic plants and invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Mallard
Survival, growth, and reproduction of avian aquatic/wetland piscivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Great blue heron

Table 4-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 1
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of mammalian aquatic/wetland piscivores	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Mink
Survival, growth, and reproduction of mammalian aquatic/wetland omnivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume aquatic/wetland prey from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Raccoon

Table 4-3
Screening Statistics - SWMU 1 - Groundwater (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Semivolatile Organic Compounds (UG/L)									
1,2,3-Trichlorobenzene	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
Acenaphthylene	1.00 - 110	0 / 13	--	--	6.17	NSV	-- / --	NSV	NO
Anthracene	0.10 - 11.0	0 / 13	--	--	0.69	0.73	-- / --	0.95	NO
Benzo(a)pyrene	0.10 - 11.0	1 / 13	0.20	OW01-PZ01-R01	0.63	0.014	1 / 13	14.3	**YES**
Benzo(b)fluoranthene	0.40 - 43.0	0 / 13	--	--	2.38	NSV	-- / --	NSV	NO
Benzo(g,h,i)perylene	0.20 - 22.0	0 / 13	--	--	1.19	NSV	-- / --	NSV	NO
Benzo(k)fluoranthene	0.81 - 86.0	0 / 13	--	--	4.78	NSV	-- / --	NSV	NO
Chrysene	0.01 - 1.10	0 / 13	--	--	0.06	NSV	-- / --	NSV	NO
Dibenz(a,h)anthracene	0.20 - 22.0	0 / 13	--	--	1.19	NSV	-- / --	NSV	NO
Hexachlorobutadiene	1.00 - 10.0	0 / 13	--	--	1.00	9.30	-- / --	0.11	NO
Indeno(1,2,3-cd)pyrene	0.40 - 43.0	0 / 13	--	--	2.38	NSV	-- / --	NSV	NO
Naphthalene	1.00 - 10.0	5 / 13	208	OW01-MW04-R01	25.5	100	1 / 13	0.26	NO
Pyrene	0.005 - 0.54	8 / 13	0.23	OW01-MW04-R01	0.03	NSV	-- / --	NSV	**YES**
Volatile Organic Compounds (UG/L)									
1,1-Dichloropropene	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
1,2,3-Trichloropropane	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
1,2,4-Trimethylbenzene	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
1,3,5-Trimethylbenzene	1.00 - 10.0	2 / 13	5.00	OW01-MW04-R01	1.38	NSV	-- / --	NSV	**YES**
1,3-Dichloropropane	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
2,2-Dichloropropane	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
Bromobenzene	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
Chloroethane	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO
Styrene	1.00 - 10.0	0 / 13	--	--	1.00	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Table 4-4
Screening Statistics - SWMU 1 - Surface Water (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Metals (UG/L)									
Aluminum	26.2 - 26.2	3 / 3	577	OW01-SW08	480	87.0	3 / 3	5.52	**YES**
Iron	19.0 - 19.0	3 / 3	1,330	OW01-SW06	1,283	320	3 / 3	4.01	**YES**
Lead	1.60 - 1.60	0 / 3	--	--	0.80	0.80	-- / --	1.00	NO
Silver	0.70 - 0.70	0 / 3	--	--	0.35	0.36	-- / --	0.97	NO
Pesticide/Polychlorinated Biphenyls (UG/L)									
4,4'-DDD	0.11 - 0.11	0 / 3	--	--	0.055	0.06	-- / --	0.92	NO
4,4'-DDT	0.11 - 0.11	0 / 3	--	--	0.055	0.001	-- / --	55.0	NO
Aroclor-1016	1.10 - 1.10	0 / 3	--	--	0.550	0.014	-- / --	39.3	NO
Aroclor-1221	2.20 - 2.30	0 / 3	--	--	1.117	0.280	-- / --	3.99	NO
Aroclor-1232	1.10 - 1.10	0 / 3	--	--	0.550	0.580	-- / --	0.95	NO
Aroclor-1242	1.10 - 1.10	0 / 3	--	--	0.550	0.053	-- / --	10.4	NO
Aroclor-1248	1.10 - 1.10	0 / 3	--	--	0.550	0.081	-- / --	6.79	NO
Aroclor-1254	1.10 - 1.10	0 / 3	--	--	0.550	0.033	-- / --	16.7	NO
Dieldrin	0.11 - 0.11	0 / 3	--	--	0.055	0.056	-- / --	0.98	NO
Endosulfan I	0.05 - 0.06	0 / 3	--	--	0.028	0.056	-- / --	0.50	NO
Endosulfan II	0.11 - 0.11	0 / 3	--	--	0.055	0.056	-- / --	0.98	NO
Endosulfan sulfate	0.11 - 0.11	0 / 3	--	--	0.055	0.056	-- / --	0.98	NO
Endrin	0.11 - 0.11	0 / 3	--	--	0.055	0.036	-- / --	1.53	NO
Endrin aldehyde	0.11 - 0.11	0 / 3	--	--	0.055	0.036	-- / --	1.53	NO
Endrin ketone	0.11 - 0.11	0 / 3	--	--	0.055	0.036	-- / --	1.53	NO
Heptachlor	0.05 - 0.06	0 / 3	--	--	0.028	0.0069	-- / --	4.03	NO
Heptachlor epoxide	0.05 - 0.06	0 / 3	--	--	0.028	0.0069	-- / --	4.03	NO
Methoxychlor	0.54 - 0.57	0 / 3	--	--	0.278	0.030	-- / --	9.28	NO
Toxaphene	5.40 - 5.70	0 / 3	--	--	2.783	0.011	-- / --	253	NO
Semivolatile Organic Compounds (UG/L)									
2,2'-Oxybis(1-chloropropane)	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
2,6-Dinitrotoluene	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
2-Methylnaphthalene	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
2-Nitroaniline	27.0 - 30.0	0 / 3	--	--	14.17	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Table 4-4 Screening Statistics - SWMU 1 - Surface Water (Downgradient) *NAS Oceana, Virginia Beach, VA*									
Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
3,3'-Dichlorobenzidine	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
3-Nitroaniline	27.0 - 30.0	0 / 3	--	--	14.17	NSV	-- / --	NSV	NO
4,6-Dinitro-2-methylphenol	27.0 - 30.0	0 / 3	--	--	14.17	2.30	-- / --	6.16	NO
4-Bromophenyl-phenylether	11.0 - 12.0	0 / 3	--	--	5.67	1.50	-- / --	3.78	NO
4-Chloro-3-methylphenol	11.0 - 12.0	0 / 3	--	--	5.67	0.30	-- / --	18.9	NO
4-Chlorophenyl-phenylether	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
4-Methylphenol	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
4-Nitroaniline	27.0 - 30.0	0 / 3	--	--	14.17	NSV	-- / --	NSV	NO
Acenaphthylene	1.10 - 1.19	0 / 3	--	--	0.57	NSV	-- / --	NSV	NO
Benzo(a)pyrene	0.11 - 0.12	0 / 3	--	--	0.06	0.014	-- / --	4.08	NO
Benzo(b)fluoranthene	0.44 - 0.48	3 / 3	0.68	OW01-SW06	0.61	NSV	-- / --	NSV	**YES**
Benzo(g,h,i)perylene	0.22 - 0.24	0 / 3	--	--	0.11	NSV	-- / --	NSV	NO
Benzo(k)fluoranthene	0.88 - 0.95	0 / 3	--	--	0.46	NSV	-- / --	NSV	NO
Carbazole	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
Chrysene	0.01 - 0.01	3 / 3	0.04	OW01-SW08	0.04	NSV	-- / --	NSV	**YES**
Di-n-octylphthalate	11.0 - 12.0	0 / 3	--	--	5.67	3.00	-- / --	1.89	NO
Dibenz(a,h)anthracene	0.22 - 0.24	0 / 3	--	--	0.11	NSV	-- / --	NSV	NO
Hexachlorobenzene	11.0 - 12.0	0 / 3	--	--	5.67	3.68	-- / --	1.54	NO
Hexachlorobutadiene	11.0 - 12.0	0 / 3	--	--	5.67	9.30	-- / --	0.61	NO
Hexachlorocyclopentadiene	11.0 - 12.0	0 / 3	--	--	5.67	5.20	-- / --	1.09	NO
Indeno(1,2,3-cd)pyrene	0.44 - 0.48	0 / 3	--	--	0.23	NSV	-- / --	NSV	NO
Pentachlorophenol	27.0 - 30.0	0 / 3	--	--	14.17	15.0	-- / --	0.94	NO
Pyrene	0.006 - 0.006	3 / 3	0.008	OW01-SW07	0.008	NSV	-- / --	NSV	**YES**
n-Nitroso-di-n-propylamine	11.0 - 12.0	0 / 3	--	--	5.67	NSV	-- / --	NSV	NO
Volatile Organic Compounds (UG/L)									
1,2-Dibromo-3-chloropropane	1.00 - 1.00	0 / 3	--	--	0.5	NSV	-- / --	NSV	NO
Chloroethane	1.00 - 1.00	0 / 3	--	--	0.5	NSV	-- / --	NSV	NO
Styrene	1.00 - 1.00	0 / 3	--	--	0.5	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shr [illegible] ls indicate hazard quotient based on reporting limits

Table 4-5
Screening Statistics - SWMU 1 - Sediment (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Inorganics (MG/KG)									
Beryllium	0.02 - 0.03	3 / 3	0.23	OW01-SD12	0.17	NSV	-- / --	NSV	**YES**
Cyanide	0.25 - 0.29	0 / 3	--	--	0.13	0.1	-- / --	1.33	NO
Thallium	0.69 - 0.97	0 / 3	--	--	0.43	NSV	-- / --	NSV	NO
Pesticide/Polychlorinated Biphenyls (UG/KG)									
4,4'-DDE	4.40 - 4.70	0 / 3	--	--	2.28	2.2	-- / --	1.04	NO
4,4'-DDT	4.40 - 4.70	0 / 3	--	--	2.28	1.58	-- / --	1.45	NO
Aldrin	2.20 - 2.30	0 / 3	--	--	1.13	2.00	-- / --	0.57	NO
Aroclor-1016	44.0 - 47.0	0 / 3	--	--	22.8	22.7	-- / --	1.01	NO
Aroclor-1221	88.0 - 94.0	0 / 3	--	--	45.7	22.7	-- / --	2.01	NO
Aroclor-1232	44.0 - 47.0	0 / 3	--	--	22.8	22.7	-- / --	1.01	NO
Aroclor-1242	44.0 - 47.0	0 / 3	--	--	22.8	22.7	-- / --	1.01	NO
Aroclor-1248	44.0 - 47.0	0 / 3	--	--	22.8	22.7	-- / --	1.01	NO
Aroclor-1254	44.0 - 47.0	0 / 3	--	--	22.8	22.7	-- / --	1.01	NO
Aroclor-1260	44.0 - 47.0	0 / 3	--	--	22.8	22.7	-- / --	1.01	NO
delta-BHC	2.20 - 2.30	0 / 3	--	--	1.13	NSV	-- / --	NSV	NO
Dieldrin	4.40 - 4.70	0 / 3	--	--	2.28	2.00	-- / --	1.14	NO
Endosulfan I	2.20 - 2.30	0 / 3	--	--	1.13	NSV	-- / --	NSV	NO
Endosulfan II	4.40 - 4.70	0 / 3	--	--	2.28	NSV	-- / --	NSV	NO
Endosulfan sulfate	4.40 - 4.70	0 / 3	--	--	2.28	NSV	-- / --	NSV	NO
Endrin	4.40 - 4.70	0 / 3	--	--	2.28	3.00	-- / --	0.76	NO
Endrin aldehyde	4.40 - 4.70	0 / 3	--	--	2.28	NSV	-- / --	NSV	NO
Endrin ketone	4.40 - 4.70	0 / 3	--	--	2.28	NSV	-- / --	NSV	NO
Heptachlor	2.20 - 2.30	0 / 3	--	--	1.13	0.3	-- / --	3.78	NO
Methoxychlor	22.0 - 23.0	0 / 3	--	--	11.3	NSV	-- / --	NSV	NO
Toxaphene	220 - 230	0 / 3	--	--	113	NSV	-- / --	NSV	NO
Semivolatile Organic Compounds (UG/KG)									
1,2,4-Trichlorobenzene	440 - 470	0 / 3	--	--	228	40	-- / --	5.71	NO
1,2-Dichlorobenzene	440 - 470	0 / 3	--	--	228	35	-- / --	6.52	NO
1,3-Dichlorobenzene	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Table 4-5
Screening Statistics - SWMU 1 - Sediment (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
1,4-Dichlorobenzene	440 - 470	0 / 3	--	--	228	110	-- / --	2.08	NO
2,2'-Oxybis(1-chloropropane)	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
2,4,5-Trichlorophenol	1,100 - 1,200	0 / 3	--	--	583	NSV	-- / --	NSV	NO
2,4,6-Trichlorophenol	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
2,4-Dichlorophenol	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
2,4-Dimethylphenol	440 - 470	0 / 3	--	--	228	29	-- / --	7.87	NO
2,4-Dinitrophenol	1,100 - 1,200	0 / 3	--	--	583	NSV	-- / --	NSV	NO
2,4-Dinitrotoluene	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
2,6-Dinitrotoluene	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
2-Chloronaphthalene	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
2-Chlorophenol	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
2-Methylnaphthalene	440 - 470	0 / 3	--	--	228	70	-- / --	3.26	NO
2-Methylphenol	440 - 470	0 / 3	--	--	228	63	-- / --	3.62	NO
2-Nitroaniline	1,100 - 1,200	0 / 3	--	--	583	NSV	-- / --	NSV	NO
2-Nitrophenol	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
3,3'-Dichlorobenzidine	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
3-Nitroaniline	1,100 - 1,200	0 / 3	--	--	583	NSV	-- / --	NSV	NO
4,6-Dinitro-2-methylphenol	1,100 - 1,200	0 / 3	--	--	583	NSV	-- / --	NSV	NO
4-Bromophenyl-phenylether	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
4-Chloro-3-methylphenol	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
4-Chloroaniline	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
4-Chlorophenyl-phenylether	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
4-Nitroaniline	1,100 - 1,200	0 / 3	--	--	583	NSV	-- / --	NSV	NO
4-Nitrophenol	1,100 - 1,200	0 / 3	--	--	583	NSV	-- / --	NSV	NO
Acenaphthene	176 - 186	0 / 3	--	--	91	16	-- / --	5.68	NO
Acenaphthylene	440 - 470	0 / 3	--	--	228	44	-- / --	5.19	NO
Anthracene	88.0 - 93.2	0 / 3	--	--	45	85.3	-- / --	0.53	NO
Benzo(k)fluoranthene	440 - 470	0 / 3	--	--	228	240	-- / --	0.95	NO
Butylbenzylphthalate	440 - 470	0 / 3	--	--	228	63	-- / --	3.62	NO
Carbazole	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Sh[illegible] cells indicate hazard quotient based on reporting limits

Table 4-5
Screening Statistics - SWMU 1 - Sediment (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Dibenz(a,h)anthracene	176 - 186	0 / 3	--	--	91	63.4	-- / --	1.43	NO
Dimethyl phthalate	440 - 470	0 / 3	--	--	228	71	-- / --	3.22	NO
Fluoranthene	440 - 932	1 / 3	705	OW01-SD12	385	600	1 / 3	0.64	NO
Fluorene	347 - 367	0 / 3	--	--	179	19	-- / --	9.43	NO
Hexachlorobenzene	440 - 470	0 / 3	--	--	228	22	-- / --	10.38	NO
Hexachlorobutadiene	440 - 470	0 / 3	--	--	228	11	-- / --	20.76	NO
Hexachlorocyclopentadiene	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
Hexachloroethane	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
Isophorone	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
Nitrobenzene	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
Pentachlorophenol	1,100 - 1,200	0 / 3	--	--	583	360	-- / --	1.62	NO
Phenol	440 - 470	0 / 3	--	--	228	420	-- / --	0.54	NO
bis(2-Chloroethoxy)methane	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
bis(2-Chloroethyl)ether	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
n-Nitroso-di-n-propylamine	440 - 470	0 / 3	--	--	228	NSV	-- / --	NSV	NO
n-Nitrosodiphenylamine	440 - 470	0 / 3	--	--	228	28	-- / --	8.15	NO
Volatile Organic Compounds (UG/KG)									
1,1,2,2-Tetrachloroethane	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
1,1-Dichloroethane	13.0 - 14.0	3 / 3	2.00	OW01-SD10	1.67	NSV	-- / --	NSV	**YES**
1,1-Dichloroethene	13.0 - 14.0	1 / 3	1.00	OW01-SD11	5.00	NSV	-- / --	NSV	**YES**
1,2-Dichloroethane	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
1,2-Dichloroethene (total)	13.0 - 14.0	3 / 3	3.00	OW01-SD10	3.00	NSV	-- / --	NSV	**YES**
1,2-Dichloropropane	13.0 - 14.0	1 / 3	1.00	OW01-SD10	4.83	NSV	-- / --	NSV	**YES**
2-Butanone	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
2-Hexanone	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
4-Methyl-2-pentanone	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
Acetone	13.0 - 14.0	3 / 3	24.0	OW01-SD12	17.0	NSV	-- / --	NSV	**YES**
Benzene	13.0 - 14.0	0 / 3	--	--	3.00	NSV	-- / --	NSV	NO
Bromodichloromethane	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
Bromoform	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Table 4-5 Screening Statistics - SWMU 1 - Sediment (Downgradient) *NAS Oceana, Virginia Beach, VA*									
Chemical	**Reporting Limit Range**	**Frequency of Detection**	**Maximum Concentration Detected**	**Sample ID of Maximum Concentration**	**Arithmetic Mean**	**Screening Value**	**Frequency of Exceedance**	**Mean Hazard Quotient[1]**	**COPC?**
Bromomethane	13.0 - 14.0	1 / 3	1.00	OW01-SD11	5.00	NSV	-- / --	NSV	**YES**
Carbon disulfide	13.0 - 14.0	3 / 3	4.00	OW01-SD12	3.33	NSV	-- / --	NSV	**YES**
Carbon tetrachloride	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
Chlorobenzene	13.0 - 14.0	3 / 3	2.00	OW01-SD10	2.00	NSV	-- / --	NSV	**YES**
Chloroethane	13.0 - 14.0	1 / 3	1.00	OW01-SD11	5.00	NSV	-- / --	NSV	**YES**
Chloroform	13.0 - 14.0	0 / 3	--	--	2.50	NSV	-- / --	NSV	NO
Chloromethane	13.0 - 14.0	2 / 3	2.00	OW01-SD11	3.33	NSV	-- / --	NSV	**YES**
Dibromochloromethane	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
Ethylbenzene	13.0 - 14.0	0 / 3	--	--	3.00	10	-- / --	0.30	NO
Methylene chloride	13.0 - 14.0	0 / 3	--	--	7.00	NSV	-- / --	NSV	NO
Styrene	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
Toluene	13.0 - 14.0	0 / 3	--	--	1.00	NSV	-- / --	NSV	NO
Vinyl chloride	13.0 - 14.0	1 / 3	1.00	OW01-SD11	5.00	NSV	-- / --	NSV	**YES**
cis-1,3-Dichloropropene	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO
trans-1,3-Dichloropropene	13.0 - 14.0	0 / 3	--	--	6.83	NSV	-- / --	NSV	NO

NSV - No Screening Value

1 - Sh[illegible]lls indicate hazard quotient based on reporting limits

Table 4-6
Screening Statistics - SWMU 1 - Surface Soil
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Inorganics (MG/KG)									
Aluminum	-- - --	3 / 3	15,700	1-SS1	12,010	50.0	3 / 3	240	**YES**
Antimony	-- - --	1 / 2	5.9	1-SS2	1.75	5.00	1 / 2	0.35	NO
Chromium	-- - --	3 / 3	20.6	1-SS2	16.0	0.40	3 / 3	40.0	**YES**
Cyanide	0.29 - 0.29	0 / 1	--	--	0.15	0.06	-- / --	2.42	NO
Iron	-- - --	3 / 3	17,300	1-SS2	8,807	200	3 / 3	44.0	**YES**
Mercury	-- - --	3 / 3	0.23	1-SS2	0.11	0.10	1 / 3	1.05	**YES**
Vanadium	-- - --	3 / 3	20.0	1-SS1	16.7	2.00	3 / 3	8.35	**YES**
Zinc	-- - --	2 / 3	85.1	1-SS2	49.7	50.0	3 / 3	0.99	NO
Pesticide/Polychlorinated Biphenyls (MG/KG)									
Aroclor-1254	20.0 - 47.0	1 / 3	140	1-SS1	57.8	100	1 / 3	0.58	NO
Endosulfan I	2.30 - 2.30	0 / 1	--	--	1.15	NSV	-- / --	NSV	NO
Endosulfan II	4.70 - 4.70	0 / 1	--	--	2.35	NSV	-- / --	NSV	NO
Endosulfan sulfate	4.70 - 4.70	0 / 1	--	--	2.35	NSV	-- / --	NSV	NO
Heptachlor	2.30 - 2.30	0 / 1	--	--	1.15	NSV	-- / --	NSV	NO
Toxaphene	230 - 230	0 / 1	--	--	115	NSV	-- / --	NSV	NO
Semivolatile Organic Compounds (UG/KG)									
1,2,4-Trichlorobenzene	470 - 470	0 / 1	--	--	235	1,270	-- / --	0.19	NO
1,2-Dichlorobenzene	6 - 470	0 / 3	--	--	235	100	-- / --	2.35	NO
1,3-Dichlorobenzene	6 - 470	0 / 3	--	--	235	NSV	-- / --	NSV	NO
2,2'-Oxybis(1-chloropropane)	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
2,4,5-Trichlorophenol	1200 - 1200	0 / 1	--	--	600	430	-- / --	1.40	NO
2,4-Dimethylphenol	470 - 470	0 / 1	--	--	235	100	-- / --	2.35	NO
2,4-Dinitrotoluene	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
2,6-Dinitrotoluene	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
2-Chlorophenol	470 - 470	0 / 1	--	--	235	100	-- / --	2.35	NO
2-Methylnaphthalene	-- - --	1 / 9	210	1-SS4	69.1	NSV	-- / --	NSV	**YES**
2-Methylphenol	470 - 470	0 / 1	--	--	235	100	-- / --	2.35	NO
2-Nitroaniline	1200 - 1200	0 / 1	--	--	600	NSV	-- / --	NSV	NO
2-Nitrophenol	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 4-6
Screening Statistics - SWMU 1 - Surface Soil
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
3,3'-Dichlorobenzidine	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
3-Nitroaniline	1200 - 1200	0 / 1	--	--	600	NSV	-- / --	NSV	NO
4,6-Dinitro-2-methylphenol	1200 - 1200	0 / 1	--	--	600	NSV	-- / --	NSV	NO
4-Bromophenyl-phenylether	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
4-Chloro-3-methylphenol	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
4-Chloroaniline	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
4-Chlorophenyl-phenylether	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
4-Methylphenol	470 - 470	0 / 1	--	--	235	100	-- / --	2.35	NO
4-Nitroaniline	1200 - 1200	0 / 1	--	--	600	NSV	-- / --	NSV	NO
4-Nitrophenol	1200 - 1200	0 / 1	--	--	600	380	-- / --	1.58	NO
Acenaphthylene	470 - 470	0 / 1	--	--	235	100	-- / --	2.35	NO
Benzo(a)anthracene	-- - --	6 / 9	220	1-SS3	103	100	4 / 9	1.03	**YES**
Benzo(a)pyrene	-- - --	6 / 9	230	1-SS2	101	100	2 / 9	1.01	**YES**
Benzo(b)fluoranthene	-- - --	3 / 9	200	1-SS2	104	100	3 / 9	1.04	**YES**
Benzo(g,h,i)perylene	-- - --	3 / 9	130	1-SS2	71.6	100	2 / 9	0.72	NO
Benzo(k)fluoranthene	-- - --	2 / 9	220	1-SS2	94.4	100	2 / 9	0.94	NO
bis(2-Chloroethoxy)methane	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
bis(2-Chloroethyl)ether	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
bis(2-Ethylhexyl)phthalate	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Butylbenzylphthalate	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Carbazole	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Chrysene	-- - --	5 / 9	290	1-SS2	107	100	3 / 9	1.07	**YES**
Di-n-octyl phthalate	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Dibenz(a,h)anthracene	56 - 186	0 / 9	--	--	37.5	100	-- / --	0.38	NO
Dibenzofuran	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Fluoranthene	-- - --	5 / 9	470	1-SS2	176	100	4 / 9	1.76	**YES**
Hexachlorobenzene	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Hexachlorobutadiene	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Hexachloroethane	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Indeno(1,2,3-cd)pyrene	-- - --	4 / 9	170	1-SS2	107	100	4 / 9	1.07	**YES**

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 4-6 Screening Statistics - SWMU 1 - Surface Soil *NAS Oceana, Virginia Beach, VA*									
Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Isophorone	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Naphthalene	-- - --	1 / 9	130	1-SS4	67.8	100	1 / 9	0.68	NO
PAH (total)	-- - --	7 / 9	2,681	1-SS2	1,274	4,100	0 / 9	0.31	NO
Phenanthrene	-- - --	4 / 9	260	1-SS2	85.1	100	3 / 9	0.85	NO
Pyrene	-- - --	6 / 9	370	1-SS2	124	100	4 / 9	1.24	**YES**
n-Nitroso-di-n-propylamine	470 - 470	0 / 1	--	--	235	NSV	-- / --	NSV	NO
Volatile Organic Compounds (UG/KG)									
1,1-Dichloroethene	14 - 14	0 / 1	--	--	7.00	NSV	-- / --	NSV	NO
2-Butanone	-- - --	1 / 9	72	1-SS1	28.3	NSV	-- / --	NSV	**YES**
2-Hexanone	14 - 14	0 / 1	--	--	7.00	NSV	-- / --	NSV	NO
Acetone	-- - --	2 / 9	20	1-SS1	11.7	NSV	-- / --	NSV	**YES**
Bromomethane	14 - 14	0 / 1	--	--	7.00	NSV	-- / --	NSV	NO
Carbon disulfide	-- - --	2 / 9	8	1-SS1	6.33	NSV	-- / --	NSV	**YES**
Chloroethane	14 - 14	0 / 1	--	--	7.00	NSV	-- / --	NSV	NO
Chloroform	-- - --	0 / 9	--	--	2.00	1,000	-- / --	0.002	NO
Chloromethane	14 - 14	0 / 1	--	--	7.00	NSV	-- / --	NSV	NO
Dibromochloromethane	14 - 14	0 / 1	--	--	7.00	NSV	-- / --	NSV	NO
Methylene chloride	-- - --	0 / 3	--	--	9.67	1,001	-- / --	0.01	NO
Tetrachloroethene	-- - --	0 / 9	--	--	1.00	401	-- / --	0.002	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 4-7
Summary of Hazard Quotients for Food Web Exposures - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	Short-tailed shrew		Deer mouse		Meadow vole		Red Fox		Raccoon		Mink	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals												
Aluminum	9.58	0.96	0.88	0.09	0.88	0.09	0.28	0.03	0.03	<0.01	0.32	0.03
Antimony	0.24	0.02	0.07	<0.01	0.15	0.01	0.03	<0.01	0.02	<0.01	0.06	<0.01
Arsenic	0.59	0.06	0.09	<0.01	0.06	<0.01	0.03	<0.01	0.08	<0.01	0.08	<0.01
Cadmium	0.39	0.04	0.08	<0.01	0.02	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	2.52	0.25	0.22	0.02	0.25	0.03	0.22	0.02	0.51	0.05	1.66	0.17
Lead	0.14	0.01	0.02	<0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury	0.33	0.07	0.07	0.01	0.06	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	0.23	0.14	0.06	0.04	0.08	0.05	0.02	0.01	0.03	0.02	0.06	0.04
Thallium	0.35	0.04	0.06	<0.01	0.02	<0.01	0.02	<0.01	0.06	<0.01	0.18	0.02
Vanadium	1.14	0.11	0.10	<0.01	0.12	0.01	0.11	0.01	0.10	0.01	0.33	0.03
Zinc	0.06	0.03	0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01
Pesticides/PCBs												
4,4'-DDD	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4,4'-DDE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4,4'-DDT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor-1016	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor-1221	0.22	0.02	0.04	<0.01	<0.01	<0.01	0.01	<0.01	0.02	<0.01	0.18	0.02
Aroclor-1232	0.11	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	<0.01
Aroclor-1242	0.11	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	<0.01
Aroclor-1248	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	<0.01
Aroclor-1254	0.28	0.03	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor-1260	0.07	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01
Dieldrin	0.07	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin Ketone	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Semivolatile Organics												
Hexachlorobenzene	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 4-7
Summary of Hazard Quotients for Food Web Exposures - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	American robin		Marsh wren		American kestrel		Great blue heron		Mallard	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals										
Aluminum	0.57	0.06	0.10	<0.01	0.44	0.04	0.99	0.10	0.01	<0.01
Antimony	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	0.01	<0.01	0.08	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	0.12	<0.01	<0.01	<0.01	0.13	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	0.22	0.04	0.05	<0.01	0.25	0.05	0.01	<0.01	<0.01	<0.01
Iron	0.42	0.04	5.56	0.56	0.29	0.03	4.43	0.44	0.19	0.02
Lead	0.41	0.04	0.10	<0.01	0.12	0.01	<0.01	<0.01	<0.01	<0.01
Mercury	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.78	0.08	0.03	<0.01
Selenium	0.07	0.02	0.21	0.11	0.05	0.01	0.17	0.08	0.03	0.02
Thallium	0.03	<0.01	0.26	0.03	0.03	<0.01	0.20	0.02	<0.01	<0.01
Vanadium	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01
Zinc	0.32	0.04	0.07	<0.01	0.34	0.04	<0.01	<0.01	<0.01	<0.01
Pesticides/PCBs										
4,4'-DDD	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4,4'-DDE	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01
4,4'-DDT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor-1016	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01
Aroclor-1221	0.02	<0.01	0.05	<0.01	0.02	<0.01	0.16	0.02	<0.01	<0.01
Aroclor-1232	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01
Aroclor-1242	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01
Aroclor-1248	0.02	<0.01	0.05	<0.01	0.02	<0.01	0.19	0.02	<0.01	<0.01
Aroclor-1254	0.04	<0.01	0.05	<0.01	0.05	<0.01	0.19	0.02	<0.01	<0.01
Aroclor-1260	0.01	<0.01	0.05	<0.01	0.01	<0.01	0.19	0.02	<0.01	<0.01
Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin Aldehyde	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin Ketone	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	0.01	<0.01	0.08	<0.01	0.01	<0.01	0.06	<0.01	<0.01	<0.01
Semivolatile Organics										
Hexachlorobenzene	0.18	0.02	0.63	0.06	0.18	0.02	0.49	0.05	0.03	<0.01

Table 4-8
Summary of COPCs - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater				Surface Water				Sediment				Surface Soil				Food Web		
	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	Receptor	Endpoint	Mean HQ
Detected Chemicals With Screening Values																			
Aluminum					3/3	3/3	6.63	5.52					3/3	3/3	314	240	Shrew	NOAEL	9.58
Benzo(a)anthracene													6/9	4/9	2.20	1.03			
Benzo(a)pyrene	1/13	1/13	14.3	--									6/9	2/9	2.30	1.01			
Benzo(b)fluoranthene													3/9	3/9	2.00	1.04			
Chromium													3/3	3/3	52	40			
Chrysene													5/9	3/9	2.90	1.07			
Fluoranthene													5/9	4/9	4.70	1.76			
Indene(1,2,3-cd)pyrene													4/9	4/9	1.70	1.07			
Iron					3/3	3/3	4.16	4.01					3/3	3/3	86	44	Shrew	NOAEL	2.52
																	Mink	NOAEL	1.66
																	Marsh wren	NOAEL	5.56
																	Great blue heron	NOAEL	4.43
Mercury													3/3	1/3	2.30	1.05			
Pyrene													6/9	4/9	3.70	1.24			
Vanadium													3/3	3/3	10	8.35	Shrew	NOAEL	1.14
Detected Chemicals Without Screening Values																			
Acetone									3/3	--	24 ug/kg	17 ug/kg	2/9	--	20 ug/kg	11.7 ug/kg			
Benzo(b)fluoranthene					3/3	--	0.68 ug/L	0.61 ug/L											
Beryllium									3/3	--	0.23 mg/kg	0.17 mg/kg							
Bromomethane									1/3	--	1.0 ug/kg	--							
2-Butanone													1/9	--	72 ug/kg	28.3 ug/kg			
Carbon disulfide									3/3	--	4.0 ug/kg	3.3 ug/kg	2/9	--	8.0 ug/kg	6.3 ug/kg			
Chlorobenzene									3/3	--	2.0 ug/kg	2.0 ug/kg							
Chloroethane									1/3	--	1.0 ug/kg	--							
Chloromethane									2/3	--	2.0 ug/kg	--							
Chrysene					3/3	--	0.04 ug/L	0.04 ug/L											
1,1-Dichloroethane									3/3	--	2.0 ug/kg	1.67 ug/kg							
1,1-Dichloroethene									1/3	--	1.0 ug/kg	--							
1,2-Dichloroethene (total)									3/3	--	3.0 ug/kg	3.0 ug/kg							
1,2-Dichloropropane									1/3	--	1.0 ug/kg	--							
2-Methylnaphthalene													1/9	--	210 ug/kg	69.1 ug/kg			
Pyrene	8/13	--	0.23 ug/L	0.03 ug/L	3/3	--	0.008 ug/L	0.008 ug/L											
1,3,5-Trimethylbenzene	2/13	--	5.0 ug/L	1.38 ug/L															
Vinyl chloride									1/3	--	1.0 ug/kg	--							

FOD - Frequency of Detection
FOE - Frequency of Exceedence

Table 4-9
Summary Statistics - SWMU 1 - Groundwater (Upgradient Wells)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Semivolatile Organic Compounds (UG/L)						
1,2,3-Trichlorobenzene	1.00 - 1.00	0 / 2	--	--	0.50	0
Acenaphthylene	1.10 - 1.10	0 / 2	--	--	0.55	0
Anthracene	0.11 - 0.11	0 / 2	--	--	0.04	0.02
Benzo(a)pyrene	0.11 - 0.11	0 / 2	--	--	0.06	0
Benzo(b)fluoranthene	0.43 - 0.45	0 / 2	--	--	0.22	0.01
Benzo(g,h,i)perylene	0.22 - 0.22	0 / 2	--	--	0.11	0
Benzo(k)fluoranthene	0.86 - 0.90	0 / 2	--	--	0.44	0.01
Chrysene	0.01 - 0.01	0 / 2	--	--	0.006	0
Dibenz(a,h)anthracene	0.22 - 0.22	0 / 2	--	--	0.11	0
Hexachlorobutadiene	1.00 - 1.00	0 / 2	--	--	0.50	0
Indeno(1,2,3-cd)pyrene	0.43 - 0.45	0 / 2	--	--	0.22	0.01
Naphthalene	1.00 - 1.00	0 / 2	--	--	0.50	0
Pyrene	0.005 - 0.006	1 / 2	0.003	OW01-MW02-R01	0.003	0
Volatile Organic Compounds (UG/L)						
1,1-Dichloropropene	1.00 - 1.00	0 / 2	--	--	0.50	0
1,2,3-Trichloropropane	1.00 - 1.00	0 / 2	--	--	0.50	0
1,2,4-Trimethylbenzene	1.00 - 1.00	0 / 2	--	--	0.50	0
1,3,5-Trimethylbenzene	1.00 - 1.00	0 / 2	--	--	0.50	0
1,3-Dichloropropane	1.00 - 1.00	0 / 2	--	--	0.50	0
2,2-Dichloropropane	1.00 - 1.00	0 / 2	--	--	0.50	0
Bromobenzene	1.00 - 1.00	0 / 2	--	--	0.50	0
Chloroethane	1.00 - 1.00	0 / 2	--	--	0.50	0
Styrene	1.00 - 1.00	0 / 2	--	--	0.50	0

[1] One-half of the reporting limit was used for non-detected samples when calculating the mean.

Table 4-10
Summary Statistics - SWMU 1 - Surface Water (Upgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Concentration Detected	Sample ID of Maximum Concentration	Upgradient Value[1]
Inorganics (UG/L)					
Aluminum	26.2 - 26.2	1 / 1	557	OW01-SW05	557
Antimony	2.20 - 2.20	0 / 1	--	--	1.10
Arsenic	2.70 - 2.70	0 / 1	--	--	1.35
Barium	0.20 - 0.20	1 / 1	27.4	OW01-SW05	27.4
Beryllium	0.10 - 0.10	0 / 1	--	--	0.05
Cadmium	0.30 - 0.30	0 / 1	--	--	0.15
Calcium	30.3 - 30.3	1 / 1	6,510	OW01-SW05	6,510
Chromium	0.60 - 0.60	1 / 1	1.20	OW01-SW05	1.20
Cobalt	0.50 - 0.50	0 / 1	--	--	0.95
Copper	0.60 - 0.60	0 / 1	--	--	1.45
Cyanide	5.00 - 5.00	0 / 1	--	--	2.50
Iron	19.0 - 19.0	1 / 1	1,320	OW01-SW05	1,320
Lead	1.60 - 1.60	0 / 1	--	--	0.80
Magnesium	28.6 - 28.6	1 / 1	4,320	OW01-SW05	4,320
Manganese	0.20 - 0.20	1 / 1	65.3	OW01-SW05	65.3
Mercury	0.10 - 0.10	0 / 1	--	--	0.05
Nickel	1.30 - 1.30	0 / 1	--	--	1.65
Potassium	12.2 - 12.2	0 / 1	--	--	520
Selenium	2.70 - 2.70	0 / 1	--	--	1.35
Silver	0.70 - 0.70	0 / 1	--	--	0.35
Sodium	162 - 162	1 / 1	8,660	OW01-SW05	8,660
Thallium	3.80 - 3.80	0 / 1	--	--	1.90
Vanadium	0.80 - 0.80	1 / 1	1.40	OW01-SW05	1.40
Zinc	1.10 - 1.10	0 / 1	--	--	8.45
Pesticide/Polychlorinated Biphenyls (UG/L)					
4,4'-DDD	0.11 - 0.11	0 / 1	--	--	0.06
4,4'-DDE	0.11 - 0.11	0 / 1	--	--	0.06
4,4'-DDT	0.11 - 0.11	0 / 1	--	--	0.06
Aldrin	0.06 - 0.06	0 / 1	--	--	0.03

Table 4-10 Summary Statistics - SWMU 1 - Surface Water (Upgradient) *NAS Oceana, Virginia Beach, VA*					
Chemical	**Reporting Limit Range**	**Frequency of Detection**	**Concentration Detected**	**Sample ID of Maximum Concentration**	**Upgradient Value[1]**
Aroclor-1016	1.10 - 1.10	0 / 1	--	--	0.55
Aroclor-1221	2.30 - 2.30	0 / 1	--	--	1.15
Aroclor-1232	1.10 - 1.10	0 / 1	--	--	0.55
Aroclor-1242	1.10 - 1.10	0 / 1	--	--	0.55
Aroclor-1248	1.10 - 1.10	0 / 1	--	--	0.55
Aroclor-1254	1.10 - 1.10	0 / 1	--	--	0.55
Aroclor-1260	1.10 - 1.10	0 / 1	--	--	0.55
Dieldrin	0.11 - 0.11	0 / 1	--	--	0.06
Endosulfan I	0.06 - 0.06	0 / 1	--	--	0.03
Endosulfan II	0.11 - 0.11	0 / 1	--	--	0.06
Endosulfan sulfate	0.11 - 0.11	0 / 1	--	--	0.06
Endrin	0.11 - 0.11	0 / 1	--	--	0.06
Endrin aldehyde	0.11 - 0.11	0 / 1	--	--	0.06
Endrin ketone	0.11 - 0.11	0 / 1	--	--	0.06
Heptachlor	0.06 - 0.06	0 / 1	--	--	0.03
Heptachlor epoxide	0.06 - 0.06	0 / 1	--	--	0.03
Methoxychlor	0.57 - 0.57	0 / 1	--	--	0.29
Toxaphene	5.70 - 5.70	0 / 1	--	--	2.85
alpha-BHC	0.06 - 0.06	0 / 1	--	--	0.03
alpha-Chlordane	0.06 - 0.06	0 / 1	--	--	0.03
beta-BHC	0.06 - 0.06	0 / 1	--	--	0.03
delta-BHC	0.06 - 0.06	0 / 1	--	--	0.03
gamma-BHC (Lindane)	0.06 - 0.06	0 / 1	--	--	0.03
gamma-Chlordane	0.06 - 0.06	0 / 1	--	--	0.03
Semivolatile Organic Compounds (UG/L)					
1,2,4-Trichlorobenzene	1.00 - 1.00	0 / 1	--	--	0.50
1,2-Dichlorobenzene	1.00 - 1.00	0 / 1	--	--	0.50
1,3-Dichlorobenzene	1.00 - 1.00	0 / 1	--	--	0.50
1,4-Dichlorobenzene	1.00 - 1.00	0 / 1	--	--	0.50
2,2'-Oxybis(1-chloropropane)	11.0 - 11.0	0 / 1	--	--	5.50

Table 4-10
Summary Statistics - SWMU 1 - Surface Water (Upgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Concentration Detected	Sample ID of Maximum Concentration	Upgradient Value[1]
2,4,5-Trichlorophenol	28.0 - 28.0	0 / 1	--	--	14.0
2,4,6-Trichlorophenol	11.0 - 11.0	0 / 1	--	--	5.50
2,4-Dichlorophenol	11.0 - 11.0	0 / 1	--	--	5.50
2,4-Dimethylphenol	11.0 - 11.0	0 / 1	--	--	5.50
2,4-Dinitrophenol	28.0 - 28.0	0 / 1	--	--	14.0
2,4-Dinitrotoluene	11.0 - 11.0	0 / 1	--	--	5.50
2,6-Dinitrotoluene	11.0 - 11.0	0 / 1	--	--	5.50
2-Chloronaphthalene	11.0 - 11.0	0 / 1	--	--	5.50
2-Chlorophenol	11.0 - 11.0	0 / 1	--	--	5.50
2-Methylnaphthalene	11.0 - 11.0	0 / 1	--	--	5.50
2-Methylphenol	11.0 - 11.0	0 / 1	--	--	5.50
2-Nitroaniline	28.0 - 28.0	0 / 1	--	--	14.0
2-Nitrophenol	11.0 - 11.0	0 / 1	--	--	5.50
3,3'-Dichlorobenzidine	11.0 - 11.0	0 / 1	--	--	5.50
3-Nitroaniline	28.0 - 28.0	0 / 1	--	--	14.0
4,6-Dinitro-2-methylphenol	28.0 - 28.0	0 / 1	--	--	14.0
4-Bromophenyl-phenylether	11.0 - 11.0	0 / 1	--	--	5.50
4-Chloro-3-methylphenol	11.0 - 11.0	0 / 1	--	--	5.50
4-Chloroaniline	11.0 - 11.0	0 / 1	--	--	5.50
4-Chlorophenyl-phenylether	11.0 - 11.0	0 / 1	--	--	5.50
4-Methylphenol	11.0 - 11.0	0 / 1	--	--	5.50
4-Nitroaniline	28.0 - 28.0	0 / 1	--	--	14.0
4-Nitrophenol	28.0 - 28.0	0 / 1	--	--	14.0
Acenaphthene	0.23 - 0.23	0 / 1	--	--	0.12
Acenaphthylene	1.16 - 1.16	0 / 1	--	--	0.58
Anthracene	0.12 - 0.12	0 / 1	--	--	0.14
Benzo(a)anthracene	0.01 - 0.01	1 / 1	0.01	OW01-SW05	0.01
Benzo(a)pyrene	0.12 - 0.12	0 / 1	--	--	0.06
Benzo(b)fluoranthene	0.46 - 0.46	1 / 1	0.45	OW01-SW05	0.45
Benzo(g,h,i)perylene	0.23 - 0.23	0 / 1	--	--	0.12

Table 4-10
Summary Statistics - SWMU 1 - Surface Water (Upgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Concentration Detected	Sample ID of Maximum Concentration	Upgradient Value[1]
Benzo(k)fluoranthene	0.93 - 0.93	0 / 1	--	--	0.46
Butylbenzylphthalate	11.0 - 11.0	0 / 1	--	--	5.50
Carbazole	*11.0 - 11.0*	*0 / 1*	--	--	5.50
Chrysene	0.01 - 0.01	1 / 1	0.02	OW01-SW05	0.02
Di-n-butylphthalate	11.0 - 11.0	0 / 1	--	--	5.50
Di-n-octylphthalate	11.0 - 11.0	0 / 1	--	--	5.50
Dibenz(a,h)anthracene	0.23 - 0.23	0 / 1	--	--	0.12
Dibenzofuran	11.0 - 11.0	0 / 1	--	--	5.50
Diethylphthalate	11.0 - 11.0	0 / 1	--	--	5.50
Dimethyl phthalate	11.0 - 11.0	0 / 1	--	--	5.50
Fluoranthene	1.16 - 1.16	0 / 1	--	--	0.86
Fluorene	0.46 - 0.46	0 / 1	--	--	0.23
Hexachlorobenzene	11.0 - 11.0	0 / 1	--	--	5.50
Hexachlorobutadiene	11.0 - 11.0	0 / 1	--	--	5.50
Hexachlorocyclopentadiene	*11.0 - 11.0*	*0 / 1*	--	--	5.50
Hexachloroethane	11.0 - 11.0	0 / 1	--	--	5.50
Indeno(1,2,3-cd)pyrene	0.46 - 0.46	0 / 1	--	--	0.23
Isophorone	11.0 - 11.0	0 / 1	--	--	5.50
Naphthalene	2.32 - 2.32	0 / 1	--	--	1.16
Nitrobenzene	11.0 - 11.0	0 / 1	--	--	5.50
Pentachlorophenol	28.0 - 28.0	0 / 1	--	--	14.0
Phenanthrene	0.06 - 0.06	1 / 1	0.03	OW01-SW05	0.03
Phenol	11.0 - 11.0	0 / 1	--	--	5.50
Pyrene	0.006 - 0.006	1 / 1	0.005	OW01-SW05	0.005
bis(2-Chloroethoxy)methane	11.0 - 11.0	0 / 1	--	--	5.50
bis(2-Chloroethyl)ether	11.0 - 11.0	0 / 1	--	--	5.50
bis(2-Ethylhexyl)phthalate	*11.0 - 11.0*	*0 / 1*	--	--	5.50
n-Nitroso-di-n-propylamine	11.0 - 11.0	0 / 1	--	--	5.50
n-Nitrosodiphenylamine	11.0 - 11.0	0 / 1	--	--	5.50

Table 4-10 Summary Statistics - SWMU 1 - Surface Water (Upgradient) *NAS Oceana, Virginia Beach, VA*					
Chemical	**Reporting Limit Range**	**Frequency of Detection**	**Concentration Detected**	**Sample ID of Maximum Concentration**	**Upgradient Value[1]**
Volatile Organic Compounds (UG/L)					
1,1,1-Trichloroethane	1.00 - 1.00	0 / 1	--	--	0.50
1,1,2,2-Tetrachloroethane	1.00 - 1.00	0 / 1	--	--	0.50
1,1,2-Trichloroethane	1.00 - 1.00	0 / 1	--	--	0.50
1,1-Dichloroethane	1.00 - 1.00	0 / 1	--	--	0.50
1,1-Dichloroethene	1.00 - 1.00	0 / 1	--	--	0.50
1,2-Dibromo-3-chloropropane	1.00 - 1.00	0 / 1	--	--	0.50
1,2-Dibromoethane	1.00 - 1.00	0 / 1	--	--	0.50
1,2-Dichloroethane	1.00 - 1.00	0 / 1	--	--	0.50
1,2-Dichloropropane	1.00 - 1.00	0 / 1	--	--	0.50
2-Hexanone	5.00 - 5.00	0 / 1	--	--	2.50
4-Methyl-2-pentanone	5.00 - 5.00	0 / 1	--	--	2.50
Benzene	1.00 - 1.00	0 / 1	--	--	0.50
Bromochloromethane	1.00 - 1.00	0 / 1	--	--	0.50
Bromodichloromethane	1.00 - 1.00	1 / 1	0.20	OW01-SW05	0.20
Bromoform	1.00 - 1.00	0 / 1	--	--	0.50
Bromomethane	1.00 - 1.00	0 / 1	--	--	0.50
Carbon disulfide	1.00 - 1.00	0 / 1	--	--	0.15
Carbon tetrachloride	1.00 - 1.00	0 / 1	--	--	0.50
Chlorobenzene	1.00 - 1.00	0 / 1	--	--	0.50
Chloroethane	1.00 - 1.00	0 / 1	--	--	0.50
Chloroform	1.00 - 1.00	0 / 1	--	--	0.55
Chloromethane	1.00 - 1.00	0 / 1	--	--	0.50
Dibromochloromethane	1.00 - 1.00	0 / 1	--	--	0.50
Ethylbenzene	1.00 - 1.00	0 / 1	--	--	0.50
Methylene chloride	2.00 - 2.00	0 / 1	--	--	0.60
Styrene	1.00 - 1.00	0 / 1	--	--	0.50
Tetrachloroethene	1.00 - 1.00	0 / 1	--	--	0.50
Toluene	1.00 - 1.00	0 / 1	--	--	0.50
Trichloroethene	1.00 - 1.00	0 / 1	--	--	0.50

Table 4-10 Summary Statistics - SWMU 1 - Surface Water (Upgradient) *NAS Oceana, Virginia Beach, VA*					
Chemical	**Reporting Limit Range**	**Frequency of Detection**	**Concentration Detected**	**Sample ID of Maximum Concentration**	**Upgradient Value[1]**
Vinyl chloride	1.00 - 1.00	0 / 1	--	--	0.50
Xylene, total	1.00 - 1.00	0 / 1	--	--	0.50
cis-1,2-Dichloroethene	1.00 - 1.00	0 / 1	--	--	0.50
cis-1,3-Dichloropropene	1.00 - 1.00	0 / 1	--	--	0.50
trans-1,2-Dichloroethene	1.00 - 1.00	0 / 1	--	--	0.50

[1] One-half of the reporting limit was used for non-detected samples when calculating the mean.

Table 4-11
Summary Statistics - SWMU 1 - Sediment (Upgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Concentration Detected	Sample ID of Maximum Concentration	Upgradient Value[1]
Inorganics (MG/KG)					
Aluminum	5.60 - 5.60	1 / 1	373	OW01-SD09	373
Antimony	0.47 - 0.47	0 / 1	--	--	0.24
Arsenic	0.57 - 0.57	0 / 1	--	--	0.29
Barium	0.04 - 0.04	1 / 1	2.60	OW01-SD09	2.60
Beryllium	0.02 - 0.02	1 / 1	0.04	OW01-SD09	0.04
Cadmium	0.06 - 0.06	0 / 1	--	--	0.05
Calcium	6.40 - 6.40	0 / 1	--	--	33.4
Chromium	0.13 - 0.13	1 / 1	1.00	OW01-SD09	1.00
Cobalt	0.11 - 0.11	0 / 1	--	--	0.13
Copper	0.13 - 0.13	0 / 1	--	--	0.44
Cyanide	0.22 - 0.22	0 / 1	--	--	0.11
Iron	4.00 - 4.00	1 / 1	693	OW01-SD09	693
Lead	0.34 - 0.34	1 / 1	0.79	OW01-SD09	0.79
Magnesium	6.00 - 6.00	0 / 1	--	--	23.2
Manganese	0.04 - 0.04	1 / 1	2.20	OW01-SD09	2.20
Mercury	0.01 - 0.01	0 / 1	--	--	0.005
Nickel	0.28 - 0.28	0 / 1	--	--	0.24
Potassium	2.60 - 2.60	0 / 1	--	--	23.4
Selenium	0.57 - 0.57	0 / 1	--	--	0.29
Silver	0.15 - 0.15	0 / 1	--	--	0.08
Sodium	34.4 - 34.4	0 / 1	--	--	17.2
Thallium	0.80 - 0.80	0 / 1	--	--	0.40
Vanadium	0.17 - 0.17	1 / 1	1.20	OW01-SD09	1.20
Zinc	0.23 - 0.23	0 / 1	--	--	1.75
Pesticide/Polychlorinated Biphenyls (UG/KG)					
4,4'-DDD	4.10 - 4.10	0 / 1	--	--	2.05
4,4'-DDE	4.10 - 4.10	0 / 1	--	--	2.05
4,4'-DDT	4.10 - 4.10	0 / 1	--	--	2.05
Aldrin	2.00 - 2.00	0 / 1	--	--	1.00

Table 4-11
Summary Statistics - SWMU 1 - Sediment (Upgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Concentration Detected	Sample ID of Maximum Concentration	Upgradient Value[1]
Aroclor-1016	41.0 - 41.0	0 / 1	--	--	20.5
Aroclor-1221	81.0 - 81.0	0 / 1	--	--	40.5
Aroclor-1232	41.0 - 41.0	0 / 1	--	--	20.5
Aroclor-1242	41.0 - 41.0	0 / 1	--	--	20.5
Aroclor-1248	41.0 - 41.0	0 / 1	--	--	20.5
Aroclor-1254	41.0 - 41.0	0 / 1	--	--	20.5
Aroclor-1260	41.0 - 41.0	0 / 1	--	--	20.5
Dieldrin	4.10 - 4.10	0 / 1	--	--	2.05
Endosulfan I	2.00 - 2.00	0 / 1	--	--	1.00
Endosulfan II	4.10 - 4.10	0 / 1	--	--	2.05
Endosulfan sulfate	4.10 - 4.10	0 / 1	--	--	2.05
Endrin	4.10 - 4.10	0 / 1	--	--	2.05
Endrin aldehyde	4.10 - 4.10	0 / 1	--	--	2.05
Endrin ketone	4.10 - 4.10	0 / 1	--	--	2.05
Heptachlor	2.00 - 2.00	0 / 1	--	--	1.00
Heptachlor epoxide	2.00 - 2.00	0 / 1	--	--	1.00
Methoxychlor	20.0 - 20.0	0 / 1	--	--	10.0
Toxaphene	200 - 200	0 / 1	--	--	100
alpha-BHC	2.00 - 2.00	0 / 1	--	--	1.00
alpha-Chlordane	2.00 - 2.00	0 / 1	--	--	1.00
beta-BHC	2.00 - 2.00	0 / 1	--	--	1.00
delta-BHC	2.00 - 2.00	0 / 1	--	--	1.00
gamma-BHC (Lindane)	2.00 - 2.00	0 / 1	--	--	1.00
gamma-Chlordane	2.00 - 2.00	0 / 1	--	--	1.00
Semivolatile Organic Compounds (UG/KG)					
1,2,4-Trichlorobenzene	410 - 410	0 / 1	--	--	205
1,2-Dichlorobenzene	410 - 410	0 / 1	--	--	205
1,3-Dichlorobenzene	410 - 410	0 / 1	--	--	205
1,4-Dichlorobenzene	410 - 410	0 / 1	--	--	205
2,2'-Oxybis(1-chloropropane)	410 - 410	0 / 1	--	--	205

Table 4-11 Summary Statistics - SWMU 1 - Sediment (Upgradient) *NAS Oceana, Virginia Beach, VA*					
Chemical	**Reporting Limit Range**	**Frequency of Detection**	**Concentration Detected**	**Sample ID of Maximum Concentration**	**Upgradient Value[1]**
2,4,5-Trichlorophenol	1,000 - 1,000	0 / 1	--	--	500
2,4,6-Trichlorophenol	410 - 410	0 / 1	--	--	205
2,4-Dichlorophenol	410 - 410	0 / 1	--	--	205
2,4-Dimethylphenol	410 - 410	0 / 1	--	--	205
2,4-Dinitrophenol	1,000 - 1,000	0 / 1	--	--	500
2,4-Dinitrotoluene	410 - 410	0 / 1	--	--	205
2,6-Dinitrotoluene	410 - 410	0 / 1	--	--	205
2-Chloronaphthalene	410 - 410	0 / 1	--	--	205
2-Chlorophenol	410 - 410	0 / 1	--	--	205
2-Methylnaphthalene	410 - 410	0 / 1	--	--	205
2-Methylphenol	410 - 410	0 / 1	--	--	205
2-Nitroaniline	1,000 - 1,000	0 / 1	--	--	500
2-Nitrophenol	410 - 410	0 / 1	--	--	205
3,3'-Dichlorobenzidine	410 - 410	0 / 1	--	--	205
3-Nitroaniline	1,000 - 1,000	0 / 1	--	--	500
4,6-Dinitro-2-methylphenol	1,000 - 1,000	0 / 1	--	--	500
4-Bromophenyl-phenylether	410 - 410	0 / 1	--	--	205
4-Chloro-3-methylphenol	410 - 410	0 / 1	--	--	205
4-Chloroaniline	410 - 410	0 / 1	--	--	205
4-Chlorophenyl-phenylether	410 - 410	0 / 1	--	--	205
4-Methylphenol	410 - 410	0 / 1	--	--	205
4-Nitroaniline	1,000 - 1,000	0 / 1	--	--	500
4-Nitrophenol	1,000 - 1,000	0 / 1	--	--	500
Acenaphthene	162 - 162	0 / 1	--	--	81.0
Acenaphthylene	410 - 410	0 / 1	--	--	205
Anthracene	81.0 - 81.0	0 / 1	--	--	40.5
Benzo(a)anthracene	8.10 - 8.10	0 / 1	--	--	4.05
Benzo(a)pyrene	81.0 - 81.0	0 / 1	--	--	40.5
Benzo(b)fluoranthene	319 - 319	1 / 1	592	OW01-SD09	592
Benzo(g,h,i)perylene	162 - 162	0 / 1	--	--	81.0

Table 4-11 Summary Statistics - SWMU 1 - Sediment (Upgradient) *NAS Oceana, Virginia Beach, VA*					
Chemical	**Reporting Limit Range**	**Frequency of Detection**	**Concentration Detected**	**Sample ID of Maximum Concentration**	**Upgradient Value[1]**
Benzo(k)fluoranthene	410 - 410	0 / 1	--	--	205
Butylbenzylphthalate	410 - 410	0 / 1	--	--	205
Carbazole	410 - 410	0 / 1	--	--	205
Chrysene	8.10 - 8.10	1 / 1	7.70	OW01-SD09	7.70
Di-n-butylphthalate	410 - 410	0 / 1	--	--	205
Di-n-octylphthalate	410 - 410	0 / 1	--	--	205
Dibenz(a,h)anthracene	162 - 162	0 / 1	--	--	81.0
Dibenzofuran	410 - 410	0 / 1	--	--	205
Diethylphthalate	410 - 410	1 / 1	45.0	OW01-SD09	45.0
Dimethyl phthalate	410 - 410	0 / 1	--	--	205
Fluoranthene	410 - 410	0 / 1	--	--	205
Fluorene	319 - 319	0 / 1	--	--	160
Hexachlorobenzene	410 - 410	0 / 1	--	--	205
Hexachlorobutadiene	410 - 410	0 / 1	--	--	205
Hexachlorocyclopentadiene	410 - 410	0 / 1	--	--	205
Hexachloroethane	410 - 410	0 / 1	--	--	205
Indeno(1,2,3-cd)pyrene	319 - 319	0 / 1	--	--	160
Isophorone	410 - 410	0 / 1	--	--	205
Naphthalene	410 - 410	0 / 1	--	--	205
Nitrobenzene	410 - 410	0 / 1	--	--	205
Pentachlorophenol	1,000 - 1,000	0 / 1	--	--	500
Phenanthrene	41.7 - 41.7	0 / 1	--	--	20.9
Phenol	410 - 410	0 / 1	--	--	205
Pyrene	4.17 - 4.17	0 / 1	--	--	2.09
bis(2-Chloroethoxy)methane	410 - 410	0 / 1	--	--	205
bis(2-Chloroethyl)ether	410 - 410	0 / 1	--	--	205
bis(2-Ethylhexyl)phthalate	410 - 410	0 / 1	--	--	205
n-Nitroso-di-n-propylamine	410 - 410	0 / 1	--	--	205
n-Nitrosodiphenylamine	410 - 410	0 / 1	--	--	205

Table 4-11 Summary Statistics - SWMU 1 - Sediment (Upgradient) *NAS Oceana, Virginia Beach, VA*					
Chemical	**Reporting Limit Range**	**Frequency of Detection**	**Concentration Detected**	**Sample ID of Maximum Concentration**	**Upgradient Value[1]**
Volatile Organic Compounds (UG/KG)					
1,1,1-Trichloroethane	12.0 - 12.0	1 / 1	2.00	OW01-SD09	2.00
1,1,2,2-Tetrachloroethane	12.0 - 12.0	0 / 1	--	--	6.00
1,1,2-Trichloroethane	12.0 - 12.0	1 / 1	2.00	OW01-SD09	2.00
1,1-Dichloroethane	12.0 - 12.0	1 / 1	2.00	OW01-SD09	2.00
1,1-Dichloroethene	12.0 - 12.0	0 / 1	--	--	6.00
1,2-Dichloroethane	12.0 - 12.0	1 / 1	1.00	OW01-SD09	1.00
1,2-Dichloroethene (total)	12.0 - 12.0	1 / 1	3.00	OW01-SD09	3.00
1,2-Dichloropropane	12.0 - 12.0	1 / 1	2.00	OW01-SD09	2.00
2-Butanone	12.0 - 12.0	0 / 1	--	--	6.00
2-Hexanone	12.0 - 12.0	0 / 1	--	--	6.00
4-Methyl-2-pentanone	12.0 - 12.0	0 / 1	--	--	6.00
Acetone	12.0 - 12.0	0 / 1	--	--	6.00
Benzene	12.0 - 12.0	0 / 1	--	--	1.00
Bromodichloromethane	12.0 - 12.0	0 / 1	--	--	6.00
Bromoform	12.0 - 12.0	0 / 1	--	--	6.00
Bromomethane	12.0 - 12.0	1 / 1	1.00	OW01-SD09	1.00
Carbon disulfide	12.0 - 12.0	0 / 1	--	--	6.00
Carbon tetrachloride	12.0 - 12.0	1 / 1	1.00	OW01-SD09	1.00
Chlorobenzene	12.0 - 12.0	1 / 1	2.00	OW01-SD09	2.00
Chloroethane	12.0 - 12.0	1 / 1	2.00	OW01-SD09	2.00
Chloroform	12.0 - 12.0	0 / 1	--	--	2.50
Chloromethane	12.0 - 12.0	1 / 1	1.00	OW01-SD09	1.00
Dibromochloromethane	12.0 - 12.0	0 / 1	--	--	6.00
Ethylbenzene	12.0 - 12.0	0 / 1	--	--	1.00
Methylene chloride	12.0 - 12.0	0 / 1	--	--	6.00
Styrene	12.0 - 12.0	0 / 1	--	--	6.00
Tetrachloroethene	12.0 - 12.0	0 / 1	--	--	1.50
Toluene	12.0 - 12.0	0 / 1	--	--	1.00
Trichloroethene	12.0 - 12.0	1 / 1	2.00	OW01-SD09	2.00

Table 4-11
Summary Statistics - SWMU 1 - Sediment (Upgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Concentration Detected	Sample ID of Maximum Concentration	Upgradient Value[1]
Vinyl chloride	12.0 - 12.0	1 / 1	1.00	OW01-SD09	1.00
Xylene, total	12.0 - 12.0	0 / 1	--	--	2.50
cis-1,3-Dichloropropene	12.0 - 12.0	0 / 1	--	--	6.00
trans-1,3-Dichloropropene	12.0 - 12.0	0 / 1	--	--	6.00

[1] One-half of the reporting limit was used for non-detected samples.

Table 4-12
Comparison of SWMU 1 Surface Water COPC Concentrations to Upgradient Concentrations
NAS Oceana, Virginia Beach, VA

Chemical	On-Site/Downgradient			Upgradient Value	On-Site Maximum Exceeds Upgradient Value?	On-Site Mean Exceeds Upgradient Value?
	Frequency of Detection	Maximum	Arithmetic Mean			
Inorganics (ug/L)						
Aluminum	3 / 3	577	480	557	NO	NO
Iron	3 / 3	1,330	1,283	1,320	NO	NO
Organics (ug/L)						
Benzo(b)fluoranthene	3 / 3	0.68	0.61	0.45	NO	NO
Chrysene	3 / 3	0.04	0.04	0.02	YES	YES
Pyrene	3 / 3	0.008	0.008	0.005	YES	YES

Table 4-13
Comparison of SWMU 1 Sediment COPC Concentrations to Upgradient Concentrations
NAS Oceana, Virginia Beach, VA

Chemical	On-Site/Downgradient Frequency of Detection	On-Site/Downgradient Maximum	On-Site/Downgradient Arithmetic Mean	Upgradient Value	On-Site Maximum Exceeds Upgradient Value?	On-Site Mean Exceeds Upgradient Value?
Inorganics (mg/kg)						
Beryllium	3 / 3	0.23	0.17	0.04	YES	YES
Organics (ug/kg)						
1,1-Dichloroethane	3 / 3	2.00	1.67	2.00	NO	NO
1,1-Dichloroethene	1 / 3	1.00	--	6.00	NO	--
1,2-Dichloroethene (total)	3 / 3	3.00	3.00	3.00	NO	NO
1,2-Dichloropropane	1 / 3	1.00	--	2.00	NO	--
Acetone	3 / 3	24.0	17.0	6.00	YES	YES
Bromomethane	1 / 3	1.00	--	1.00	NO	--
Carbon disulfide	3 / 3	4.00	3.33	6.00	NO	NO
Chlorobenzene	3 / 3	2.00	2.00	2.00	NO	NO
Chloroethane	1 / 3	1.00	--	2.00	NO	--
Chloromethane	2 / 3	2.00	--	1.00	YES	--
Vinyl chloride	1 / 3	1.00	--	1.00	NO	--

Table 4-14
Comparison of SWMU 1 Surface Soil COPC Concentrations to Background Concentrations
NAS Oceana, Virginia Beach, VA

Chemical	On-Site			Background [1]		On-Site Maximum Exceeds Upgradient Maximum?	On-Site Mean Exceeds Upgradient Mean?
	Frequency of Detection	Maximum	Arithmetic Mean	Maximum	Arithmetic Mean		
Inorganics (mg/kg)							
Aluminum	3 / 3	15,700	12,010	100,000	66,000	NO	NO
Chromium	3 / 3	20.6	16.0	19.5	15.7	NO	NO
Iron	3 / 3	17,300	8,807	100,000	25,000	NO	NO
Mercury	3 / 3	0.23	0.11	0.12	0.115	YES	NO
Vanadium	3 / 3	20.0	16.7	500	76	NO	NO
Organics (ug/kg)							
2-Methylnaphthalene	1 / 9	210	69.1	26	23	YES	YES
Benzo(a)anthracene	6 / 9	220	103	220	56	NO	YES
Benzo(a)pyrene	6 / 9	230	101	340	83	NO	NO
Benzo(b)fluoranthene	3 / 9	200	104	270	63	NO	YES
Chrysene	5 / 9	290	107	320	79	NO	NO
Fluoranthene	5 / 9	470	176	580	136	NO	NO
Indeno(1,2,3-cd)pyrene	4 / 9	170	107	97	32	YES	YES
Pyrene	6 / 9	370	124	430	106	NO	NO
2-Butanone	1 / 9	72	28.3	--	--	--	--
Acetone	2 / 9	20	11.7	--	--	--	--
Carbon disulfide	2 / 9	8.00	6.33	--	--	--	--

1 - CH2M HILL, Inc. 2000c. Final Technical Memorandum - Ecological evaluation of SWMU 15 Biopile soils, Naval Air Station, Oceana, Virginia Beach, Virginia. 27 March.

Table 5-1
Summary of COPCs from the Screening ERA - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
Inorganics															
Aluminum	X			X			X			X			X		
Arsenic													X		
Barium													X		
Beryllium									X						
Chromium										X			X		
Cobalt													X		
Copper	X														
Cyanide				X			X				X				
Iron	X									X			X		
Lead	X						X			X			X		
Manganese	X														
Mercury													X		
Silver		X			X										
Thallium									X						
Vanadium										X			X		
Zinc	X												X		
Pesticides/Polychlorinated Biphenyls															
4,4'-DDD		X			X										
4,4'-DDE								X							
4,4'-DDT		X			X			X							
Aldrin								X							
Aroclor-1016		X			X			X							
Aroclor-1221		X			X			X						X	
Aroclor-1232		X			X			X						X	
Aroclor-1242		X			X			X						X	
Aroclor-1248		X			X			X						X	
Aroclor-1254		X			X			X		X			X		
Aroclor-1260								X		X			X		
Dieldrin		X			X			X							
Endosulfan I		X							X			X			
Endosulfan II		X			X				X			X			

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 5-1
Summary of COPCs from the Screening ERA - SWMU 15
NAS Oceana, Virginia Beach, VA

	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
Endosulfan sulfate		X			X				X			X			
Endrin		X			X			X							
Endrin aldehyde		X			X				X						
Endrin ketone		X			X				X						
Heptachlor		X			X			X				X			
Heptachlor epoxide		X			X										
Methoxychlor		X			X				X						
Toxaphene		X			X				X			X			
delta-BHC									X						
Semivolatile Organic Compounds															
1,2,4-Trichlorobenzene								X			X				
1,2-Dichlorobenzene								X			X				
1,3-Dichlorobenzene									X			X			
1,4-Dichlorobenzene								X			X				
2,2'-Oxybis(1-chloropropane)			X			X			X			X			
2,4,5-Trichlorophenol									X		X				
2,4,6-*Trichlorophenol*									X		X				
2,4-Dichlorophenol									X						
2,4-Dimethylphenol								X			X				
2,4-Dinitrophenol									X						
2,4-Dinitrotoluene									X			X			
2,6-Dinitrotoluene			X			X			X			X			
2-Chloronaphthalene									X		X				
2-Chlorophenol									X		X				
2-Methylnaphthalene			X			X	X					X			
2-Methylphenol								X			X				
2-Nitroaniline			X			X			X			X			
2-Nitrophenol									X			X			
3,3'-Dichlorobenzidine			X			X			X			X			
3-Nitroaniline			X			X			X			X			
4,6-Dinitro-2-methylphenol		X			X				X			X			
4-Bromophenyl-phenylether		X			X				X			X			
4-Chloro-3-methylphenol		X			X				X			X			

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 5-1
Summary of COPCs from the Screening ERA - SWMU 15
NAS Oceana, Virginia Beach, VA

	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
4-Chloroaniline									X			X			
4-Chlorophenyl-phenylether			X			X			X			X			
4-Methylphenol			X			X					X				
4-Nitroaniline			X			X			X			X			
4-Nitrophenol									X		X				
Acenaphthene							X			X					
Acenaphthylene			X			X					X				
Anthracene										X					
Benzo(a)anthracene										X			X		
Benzo(a)pyrene		X			X					X			X		
Benzo(b)fluoranthene			X			X				X			X		
Benzo(g,h,i)perylene			X			X				X					
Benzo(k)fluoranthene			X			X		X		X					
Butylbenzylphthalate								X				X			
Carbazole			X			X			X			X			
Chrysene			X			X				X			X		
Di-n-butylphthalate															
Di-n-octyl phthalate		X			X							X			
Dibenz(a,h)anthracene			X			X				X			X		
Dibenzofuran								X				X			
Diethylphthalate							X								
Dimethyl phthalate								X							
Fluoranthene							X			X					
Fluorene							X			X			X		
Hexachlorobenzene		X			X			X				X		X	
Hexachlorobutadiene		X			X			X				X			
Hexachlorocyclopentadiene		X			X				X		X				
Hexachloroethane									X			X			
Indeno(1,2,3-cd)pyrene			X			X				X					
Isophorone									X			X			
Naphthalene										X					
Nitrobenzene									X		X				
Pentachlorophenol		X			X			X			X			X	

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 5-1
Summary of COPCs from the Screening ERA - SWMU 15
NAS Oceana, Virginia Beach, VA

	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
Phenanthrene										X					
Phenol								X			X				
Pyrene			X			X				X					
bis(2-Chloroethoxy)methane									X			X			
bis(2-Chloroethyl)ether									X			X			
bis(2-Ethylhexyl)phthalate												X			
n-Nitroso-di-n-propylamine			X			X			X			X			
n-Nitrosodiphenylamine								X			X				
Volatile Organic Compounds															
1,1,2,2-Tetrachloroethane									X						
1,1-Dichloroethane									X						
1,1-Dichloroethene									X			X			
1,2-Dibromo-3-chloropropane			X			X									
1,2-Dibromoethane		X													
1,2-Dichloroethane									X						
1,2-Dichloroethene (total)									X						
1,2-Dichloropropane									X						
2-Butanone									X			X			
2-Hexanone									X			X			
4-Methyl-2-pentanone									X						
Acetone									X			X			
Benzene	X								X						
Bromodichloromethane									X						
Bromoform									X						
Bromomethane		X							X			X			
Carbon disulfide	X								X			X			
Carbon tetrachloride									X						
Chlorobenzene		X							X						
Chloroethane			X			X			X			X			
Chloroform									X						
Chloromethane									X			X			
Dibromochloromethane									X			X			
Ethylbenzene							X								

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 5-1
Summary of COPCs from the Screening ERA - SWMU 15
NAS Oceana, Virginia Beach, VA

	Groundwater			Surface Water			Sediment			Surface Soil			Food web		
Methane			X												
Methylene chloride									X						
Styrene			X			X			X						
Toluene									X						
Vinyl chloride									X						
Xylene	X						X								
cis-1,3-Dichloropropene									X						
trans-1,3-Dichloropropene									X						

MD - Maximum detect exceeds screening value
MRL - Not detected; maximum reporting limit exceeds screening value
NSV - No screening value
Shaded cells indicate COPC based on MD.

Table 5-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 15
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Terrestrial Habitats			
Survival, growth, and reproduction of terrestrial soil invertebrate communities.	Are site-related surface soil concentrations sufficient to adversely effect soil invertebrate communities based on conservative screening values?	Comparison of mean chemical concentrations in surface soil with soil screening values.	Soil Invertebrates (earthworms)
Survival, growth, and reproduction of terrestrial plant communities.	Are site-related surface soil concentrations sufficient to adversely effect terrestrial plant communities based on conservative screening values?	Comparison of mean chemical concentrations in surface soil with soil screening values.	Terrestrial plants
Survival, growth, and reproduction of avian terrestrial insectivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	American robin
Survival, growth, and reproduction of avian terrestrial carnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	American kestrel
Survival, growth, and reproduction of mammalian terrestrial insectivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Short-tailed shrew
Survival, growth, and reproduction of mammalian terrestrial omnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume plants and invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Deer Mouse

Table 5-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 15
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of mammalian terrestrial herbivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume plants from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Meadow vole
Survival, growth, and reproduction of mammalian terrestrial carnivores.	Are site-related chemical concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean soil concentrations.	Red fox
Survival, growth, and reproduction of terrestrial reptiles.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptile species?	Evidence of potential risk to other upper trophic level terrestrial receptors evaluated in the ERA.	--
Wetland and Aquatic Habitats			
Survival, growth, and reproduction of benthic invertebrate communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect benthic invertebrate communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Benthic invertebrates
Survival, growth, and reproduction of aquatic and wetland plant communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect aquatic or wetland plant communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Aquatic/wetland plants
Survival, growth, and reproduction of fish communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect fish communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Freshwater fish

Table 5-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 15
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of amphibian communities.	Are site-related chemical concentrations in surface water and/or sediment sufficient to adversely effect amphibian communities?	Comparison of mean chemical concentrations in surface water and/or sediment with medium-specific screening values.	Amphibians
Survival, growth, and reproduction of amphibians.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to amphibian species that may consume aquatic invertebrates from the site?	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA.	--
Survival, growth, and reproduction of wetland reptiles.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to aquatic/wetland reptile species?	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA.	--
Survival, growth, and reproduction of avian aquatic/wetland insectivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Marsh wren
Survival, growth, and reproduction of avian aquatic/wetland omnivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic plants and invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Mallard
Survival, growth, and reproduction of avian aquatic/wetland piscivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Great blue heron

Table 5-2
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - SWMU 15
NAS Oceana, Virginia Beach, VA

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of mammalian aquatic/wetland piscivores	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Mink
Survival, growth, and reproduction of mammalian aquatic/wetland omnivores.	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian species that may consume aquatic plants and invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations.	Raccoon

Table 5-3
Screening Statistics - SWMU 15 - Groundwater (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient [1]	COPC ?
Inorganics (UG/L)									
Aluminum	26.2 - 26.2	2 / 7	585	OW15-MW18-R01	202	87.0	2 / 7	2.33	**YES**
Copper	0.60 - 0.60	1 / 7	13.7	OW15-MW06-R01	4.07	20.5	1 / 7	0.20	NO
Iron	19.0 - 19.0	7 / 7	15,400	OW15-MW21-R01	7,334	320	7 / 7	22.9	**YES**
Lead	1.60 - 1.60	1 / 7	2.90	OW15-MW06-R01	1.10	10.3	1 / 7	0.11	NO
Manganese	0.20 - 0.20	7 / 7	490	OW15-MW21-R01	175	120	4 / 7	1.46	**YES**
Silver	0.70 - 0.70	0 / 7	--	--	0.38	0.36	-- / --	1.05	NO
Zinc	1.10 - 1.10	5 / 7	112	OW15-MW06-R01	32.5	262	2 / 7	0.12	NO
Pesticide/Polychlorinated Biphenyls (UG/L)									
4,4'-DDD	0.10 - 0.11	0 / 7	--	--	0.05	0.06	-- / --	0.88	NO
4,4'-DDT	0.10 - 0.11	0 / 7	--	--	0.05	0.001	-- / --	52.9	NO
Aroclor-1016	1.00 - 1.10	0 / 7	--	--	0.53	0.014	-- / --	37.8	NO
Aroclor-1221	2.00 - 2.30	0 / 7	--	--	1.07	0.28	-- / --	3.83	NO
Aroclor-1232	1.00 - 1.10	0 / 7	--	--	0.53	0.58	-- / --	0.91	NO
Aroclor-1242	1.00 - 1.10	0 / 7	--	--	0.53	0.053	-- / --	9.97	NO
Aroclor-1248	1.00 - 1.10	0 / 7	--	--	0.53	0.081	-- / --	6.53	NO
Aroclor-1254	1.00 - 1.10	0 / 7	--	--	0.53	0.033	-- / --	16.0	NO
Dieldrin	0.10 - 0.11	0 / 7	--	--	0.05	0.056	-- / --	0.94	NO
Endosulfan I	0.05 - 0.06	0 / 7	--	--	0.03	0.056	-- / --	0.47	NO
Endosulfan II	0.10 - 0.11	0 / 7	--	--	0.05	0.056	-- / --	0.94	NO
Endosulfan sulfate	0.10 - 0.11	0 / 7	--	--	0.05	0.056	-- / --	0.94	NO
Endrin	0.10 - 0.11	0 / 7	--	--	0.05	0.036	-- / --	1.47	NO
Endrin aldehyde	0.10 - 0.11	0 / 7	--	--	0.05	0.036	-- / --	1.47	NO
Endrin ketone	0.10 - 0.11	0 / 7	--	--	0.05	0.036	-- / --	1.47	NO
Heptachlor	0.05 - 0.06	0 / 7	--	--	0.03	0.0069	-- / --	3.85	NO
Heptachlor epoxide	0.05 - 0.06	0 / 7	--	--	0.03	0.0069	-- / --	3.85	NO
Methoxychlor	0.50 - 0.57	0 / 7	--	--	0.27	0.030	-- / --	8.86	NO
Toxaphene	5.00 - 5.70	0 / 7	--	--	2.66	0.011	-- / --	242	NO
Semivolatile Organic Compounds (UG/L)									
2,2'-Oxybis(1-chloropropane)	11.0 - 12.0	0 / 7	--	--	5.64	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-3
Screening Statistics - SWMU 15 - Groundwater (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient [1]	COPC ?
2,6-Dinitrotoluene	11.0 - 12.0	0 / 7	--	--	5.64	NSV	-- / --	NSV	NO
2-Methylnaphthalene	11.0 - 12.0	1 / 7	4.00	OW15-MW19-R01	5.43	NSV	-- / --	NSV	**YES**
2-Nitroaniline	28.0 - 29.0	0 / 7	--	--	14.1	NSV	-- / --	NSV	NO
3,3'-Dichlorobenzidine	11.0 - 12.0	0 / 7	--	--	5.64	NSV	-- / --	NSV	NO
3-Nitroaniline	28.0 - 29.0	0 / 7	--	--	14.1	NSV	-- / --	NSV	NO
4,6-Dinitro-2-methylphenol	28.0 - 29.0	0 / 7	--	--	14.1	2.30	-- / --	6.12	NO
4-Bromophenyl-phenylether	11.0 - 12.0	0 / 7	--	--	5.64	1.50	-- / --	3.76	NO
4-Chloro-3-methylphenol	11.0 - 12.0	0 / 7	--	--	5.64	0.30	-- / --	18.8	NO
4-Chlorophenyl-phenylether	11.0 - 12.0	0 / 7	--	--	5.64	NSV	-- / --	NSV	NO
4-Methylphenol	11.0 - 12.0	0 / 7	--	--	5.64	NSV	-- / --	NSV	NO
4-Nitroaniline	28.0 - 29.0	0 / 7	--	--	14.1	NSV	-- / --	NSV	NO
Acenaphthylene	1.00 - 12.0	0 / 7	--	--	1.29	NSV	-- / --	NSV	NO
Benzo(a)pyrene	0.10 - 12.0	0 / 7	--	--	0.90	0.014	-- / --	64.3	NO
Benzo(b)fluoranthene	0.40 - 12.0	0 / 7	--	--	1.03	NSV	-- / --	NSV	NO
Benzo(g,h,i)perylene	0.20 - 12.0	0 / 7	--	--	0.94	NSV	-- / --	NSV	NO
Benzo(k)fluoranthene	0.80 - 12.0	0 / 7	--	--	1.21	NSV	-- / --	NSV	NO
Carbazole	11.0 - 12.0	0 / 7	--	--	5.64	NSV	-- / --	NSV	NO
Chrysene	0.01 - 12.0	5 / 7	0.06	OW15-MW21-R01	0.88	NSV	-- / --	NSV	**YES**
Di-n-octylphthalate	11.0 - 12.0	0 / 7	--	--	5.64	3.00	-- / --	1.88	NO
Dibenz(a,h)anthracene	0.20 - 12.0	0 / 7	--	--	0.94	NSV	-- / --	NSV	NO
Hexachlorobenzene	11.0 - 12.0	0 / 7	--	--	5.64	3.68	-- / --	1.53	NO
Hexachlorobutadiene	11.0 - 12.0	0 / 7	--	--	5.64	9.30	-- / --	0.61	NO
Hexachlorocyclopentadiene	11.0 - 12.0	0 / 7	--	--	5.64	5.20	-- / --	1.09	NO
Indeno(1,2,3-cd)pyrene	0.40 - 12.0	0 / 7	--	--	1.03	NSV	-- / --	NSV	NO
Pentachlorophenol	28.0 - 29.0	0 / 7	--	--	14.07	15.0	-- / --	0.94	NO
Pyrene	0.005 - 12.0	4 / 7	0.01	OW15-MW21-R01	0.86	NSV	-- / --	NSV	**YES**
n-Nitroso-di-n-propylamine	11.0 - 12.0	0 / 7	--	--	5.64	NSV	-- / --	NSV	NO
Volatile Organic Compounds (UG/L)									
1,2-Dibromo-3-chloropropane	1.00 - 200	0 / 7	--	--	16	NSV	-- / --	NSV	NO
1,2-Dibromoethane	1.00 - 200	0 / 7	--	--	16	180	-- / --	0.09	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-3
Screening Statistics - SWMU 15 - Groundwater (Downgradient)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient [1]	COPC ?
Benzene	1.00 - 200	5 / 7	3,444	OW15-MW07-R01	564	530	1 / 7	1.06	**YES**
Bromomethane	1.00 - 200	0 / 7	--	--	16	110	-- / --	0.15	NO
Carbon disulfide	1.00 - 200	2 / 7	194	OW15-MW07-R01	32.2	2.00	2 / 7	16.1	**YES**
Chlorobenzene	1.00 - 200	0 / 7	--	--	16	130	-- / --	0.12	NO
Chloroethane	1.00 - 200	0 / 7	--	--	16	NSV	-- / --	NSV	NO
Methane	3.00 - 3.00	7 / 7	3,200	OW15-MW07-R01	968	NSV	-- / --	NSV	**YES**
Styrene	1.00 - 200	0 / 7	--	--	16	NSV	-- / --	NSV	NO
Xylene, total	1.00 - 200	2 / 7	882	OW15-MW19-R01	152	130	1 / 7	1.17	**YES**

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-4
Screening Statistics - SWMU 15 - Surface Water
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Inorganics (UG/L)									
Aluminum	38.2 - 38.2	5 / 5	191	OW15-SW04	128	87.0	5 / 5	1.48	**YES**
Cyanide	5.00 - 5.00	1 / 5	5.60	OW15-SW03	3.12	5.20	1 / 5	0.60	NO
Silver	0.90 - 0.90	0 / 5	--	--	0.45	0.36	-- / --	1.25	NO
Pesticide/Polychlorinated Biphenyls (UG/L)									
4,4'-DDD	0.10 - 0.11	0 / 2	--	--	0.05	0.060	-- / --	0.88	NO
4,4'-DDT	0.10 - 0.11	0 / 2	--	--	0.05	0.001	-- / --	52.5	NO
Aroclor-1016	1.00 - 1.10	0 / 2	--	--	0.53	0.014	-- / --	37.5	NO
Aroclor-1221	2.10 - 2.10	0 / 2	--	--	1.03	0.280	-- / --	3.66	NO
Aroclor-1232	1.00 - 1.10	0 / 2	--	--	0.53	0.580	-- / --	0.91	NO
Aroclor-1242	1.00 - 1.10	0 / 2	--	--	0.53	0.053	-- / --	9.91	NO
Aroclor-1248	1.00 - 1.10	0 / 2	--	--	0.53	0.081	-- / --	6.48	NO
Aroclor-1254	1.00 - 1.10	0 / 2	--	--	0.53	0.033	-- / --	15.9	NO
Dieldrin	0.10 - 0.11	0 / 2	--	--	0.05	0.056	-- / --	0.94	NO
Endosulfan II	0.10 - 0.11	0 / 2	--	--	0.05	0.056	-- / --	0.94	NO
Endosulfan sulfate	0.10 - 0.11	0 / 2	--	--	0.05	0.056	-- / --	0.94	NO
Endrin	0.10 - 0.11	0 / 2	--	--	0.05	0.036	-- / --	1.46	NO
Endrin aldehyde	0.10 - 0.11	0 / 2	--	--	0.05	0.036	-- / --	1.46	NO
Endrin ketone	0.10 - 0.11	0 / 2	--	--	0.05	0.036	-- / --	1.46	NO
Heptachlor	0.05 - 0.05	0 / 2	--	--	0.03	0.0069	-- / --	3.77	NO
Heptachlor epoxide	0.05 - 0.05	0 / 2	--	--	0.03	0.0069	-- / --	3.77	NO
Methoxychlor	0.52 - 0.53	0 / 2	--	--	0.26	0.030	-- / --	8.67	NO
Toxaphene	5.20 - 5.30	0 / 2	--	--	2.60	0.011	-- / --	236	NO
Semivolatile Organic Compounds (UG/L)									
2,2'-Oxybis(1-chloropropane)	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
2,6-Dinitrotoluene	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
2-Methylnaphthalene	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
2-Nitroaniline	26.0 - 26.0	0 / 5	--	--	13.0	NSV	-- / --	NSV	NO
3,3'-Dichlorobenzidine	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
3-Nitroaniline	26.0 - 26.0	0 / 5	--	--	13.0	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-4
Screening Statistics - SWMU 15 - Surface Water
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
4,6-Dinitro-2-methylphenol	26.0 - 26.0	0 / 5	--	--	13.0	2.30	-- / --	5.65	NO
4-Bromophenyl-phenylether	10.0 - 10.0	0 / 5	--	--	5.00	1.50	-- / --	3.33	NO
4-Chloro-3-methylphenol	10.0 - 10.0	0 / 5	--	--	5.00	0.30	-- / --	16.7	NO
4-Chlorophenyl-phenylether	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
4-Methylphenol	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
4-Nitroaniline	26.0 - 26.0	0 / 5	--	--	13.0	NSV	-- / --	NSV	NO
Acenaphthylene	1.00 - 1.00	0 / 5	--	--	0.50	NSV	-- / --	NSV	NO
Benzo(a)pyrene	0.10 - 0.10	0 / 5	--	--	0.05	0.014	-- / --	3.57	NO
Benzo(b)fluoranthene	0.40 - 0.40	0 / 5	--	--	0.20	NSV	-- / --	NSV	NO
Benzo(g,h,i)perylene	0.20 - 0.20	1 / 5	1.86	OW15-SW04	0.45	NSV	-- / --	NSV	**YES**
Benzo(k)fluoranthene	0.80 - 0.80	0 / 5	--	--	0.40	NSV	-- / --	NSV	NO
Carbazole	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
Chrysene	0.01 - 0.01	3 / 5	0.04	OW15-SW05	0.02	NSV	-- / --	NSV	**YES**
Di-n-octylphthalate	10.0 - 10.0	0 / 5	--	--	5.00	3.00	-- / --	1.67	NO
Dibenz(a,h)anthracene	0.20 - 0.20	0 / 5	--	--	0.10	NSV	-- / --	NSV	NO
Hexachlorobenzene	10.0 - 10.0	0 / 5	--	--	5.00	3.68	-- / --	1.36	NO
Hexachlorobutadiene	10.0 - 10.0	0 / 5	--	--	5.00	9.30	-- / --	0.54	NO
Hexachlorocyclopentadiene	10.0 - 10.0	0 / 5	--	--	5.00	5.20	-- / --	0.96	NO
Indeno(1,2,3-cd)pyrene	0.40 - 0.40	1 / 5	0.10	OW15-SW04	0.18	NSV	-- / --	NSV	**YES**
Pentachlorophenol	26.0 - 26.0	0 / 5	--	--	13.0	15.0	-- / --	0.87	NO
Pyrene	0.005 - 0.005	1 / 5	0.01	OW15-SW04	0.005	NSV	-- / --	NSV	**YES**
n-Nitroso-di-n-propylamine	10.0 - 10.0	0 / 5	--	--	5.00	NSV	-- / --	NSV	NO
Volatile Organic Compounds (UG/L)									
1,2-Dibromo-3-chloropropane	1.00 - 1.00	0 / 2	--	--	0.50	NSV	-- / --	NSV	NO
Chloroethane	1.00 - 1.00	0 / 2	--	--	0.50	NSV	-- / --	NSV	NO
Styrene	1.00 - 1.00	0 / 2	--	--	0.50	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-5 Screening Statistics - SWMU 15 - Sediment *NAS Oceana, Virginia Beach, Virginia*									
Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Inorganics (MG/KG)									
Aluminum	5.60 - 11.2	16 / 16	29,500	OW15-SD16-0.0	11,984	25,500	2 / 16	0.47	NO
Beryllium	0.02 - 0.03	16 / 16	0.98	OW15-SD16-0.0	0.39	NSV	-- / --	NSV	**YES**
Cyanide	0.22 - 0.37	5 / 16	1.20	OW15-SD06-5.5	0.31	0.10	5 / 16	3.12	**YES**
Lead	0.19 - 0.50	16 / 16	72.7	OW15-SD16-0.0	12.5	46.7	1 / 16	0.27	NO
Thallium	0.62 - 0.94	1 / 7	0.87	OW15-SD11-2.5	0.47	NSV	-- / --	NSV	**YES**
Pesticide/Polychlorinated Biphenyls (UG/KG)									
4,4'-DDE	4.10 - 4.90	0 / 6	--	--	2.22	2.20	-- / --	1.01	NO
4,4'-DDT	4.10 - 4.90	0 / 6	--	--	2.22	1.58	-- / --	1.40	NO
Aldrin	2.10 - 2.40	0 / 6	--	--	1.11	2.00	-- / --	0.55	NO
Aroclor-1016	41.0 - 49.0	0 / 6	--	--	22.2	22.7	-- / --	0.98	NO
Aroclor-1221	82.0 - 98.0	0 / 6	--	--	44.3	22.7	-- / --	1.95	NO
Aroclor-1232	41.0 - 49.0	0 / 6	--	--	22.2	22.7	-- / --	0.98	NO
Aroclor-1242	41.0 - 49.0	0 / 6	--	--	22.2	22.7	-- / --	0.98	NO
Aroclor-1248	41.0 - 49.0	0 / 6	--	--	22.2	22.7	-- / --	0.98	NO
Aroclor-1254	41.0 - 49.0	0 / 6	--	--	22.2	22.7	-- / --	0.98	NO
Aroclor-1260	41.0 - 49.0	0 / 6	--	--	22.2	22.7	-- / --	0.98	NO
Dieldrin	4.10 - 4.90	0 / 6	--	--	2.22	2.00	-- / --	1.11	NO
Endosulfan I	2.10 - 2.40	0 / 6	--	--	1.11	NSV	-- / --	NSV	NO
Endosulfan II	4.10 - 4.90	0 / 6	--	--	2.22	NSV	-- / --	NSV	NO
Endosulfan sulfate	4.10 - 4.90	0 / 6	--	--	2.22	NSV	-- / --	NSV	NO
Endrin	4.10 - 4.90	0 / 6	--	--	2.22	3.00	-- / --	0.74	NO
Endrin aldehyde	4.10 - 4.90	0 / 6	--	--	2.22	NSV	-- / --	NSV	NO
Endrin ketone	4.10 - 4.90	0 / 6	--	--	2.22	NSV	-- / --	NSV	NO
Heptachlor	2.10 - 2.40	0 / 6	--	--	1.11	0.30	-- / --	3.69	NO
Methoxychlor	21.0 - 24.0	0 / 6	--	--	11.1	NSV	-- / --	NSV	NO
Toxaphene	210 - 240	0 / 6	--	--	111	NSV	-- / --	NSV	NO
delta-BHC	2.10 - 2.40	0 / 6	--	--	1.11	NSV	-- / --	NSV	NO
Semivolatile Organic Compounds (UG/KG)									
1,2,4-Trichlorobenzene	420 - 580	0 / 14	--	--	235	40.0	-- / --	5.88	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-5
Screening Statistics - SWMU 15 - Sediment
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
1,2-Dichlorobenzene	420 - 580	0 / 14	--	--	235	35.0	-- / --	6.72	NO
1,3-Dichlorobenzene	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
1,4-Dichlorobenzene	420 - 580	0 / 14	--	--	235	110	-- / --	2.14	NO
2,2'-Oxybis(1-chloropropane)	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
2,4,5-Trichlorophenol	1,000 - 1,500	0 / 16	--	--	578	NSV	-- / --	NSV	NO
2,4,6-Trichlorophenol	410 - 580	0 / 16	--	--	230	NSV	-- / --	NSV	NO
2,4-Dichlorophenol	410 - 580	0 / 16	--	--	230	NSV	-- / --	NSV	NO
2,4-Dimethylphenol	410 - 580	0 / 16	--	--	230	29.0	-- / --	7.93	NO
2,4-Dinitrophenol	1,000 - 1,500	0 / 16	--	--	578	NSV	-- / --	NSV	NO
2,4-Dinitrotoluene	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
2,6-Dinitrotoluene	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
2-Chloronaphthalene	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
2-Chlorophenol	410 - 580	0 / 16	--	--	230	NSV	-- / --	NSV	NO
2-Methylnaphthalene	420 - 580	1 / 14	250	OW15-SD07-7.0	233	70.0	1 / 14	3.32	YES
2-Methylphenol	410 - 580	0 / 16	--	--	230	63.0	-- / --	3.65	NO
2-Nitroaniline	1,100 - 1,500	0 / 14	--	--	593	NSV	-- / --	NSV	--
2-Nitrophenol	410 - 580	0 / 16	--	--	230	NSV	-- / --	NSV	--
3,3'-Dichlorobenzidine	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	--
3-Nitroaniline	1,100 - 1,500	0 / 14	--	--	593	NSV	-- / --	NSV	--
4,6-Dinitro-2-methylphenol	1,000 - 1,500	0 / 16	--	--	578	NSV	-- / --	NSV	--
4-Bromophenyl-phenylether	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	--
4-Chloro-3-methylphenol	410 - 580	0 / 16	--	--	230	NSV	-- / --	NSV	--
4-Chloroaniline	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	--
4-Chlorophenyl-phenylether	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	--
4-Nitroaniline	1,100 - 1,500	0 / 14	--	--	593	NSV	-- / --	NSV	--
4-Nitrophenol	1,000 - 1,500	0 / 16	--	--	578	NSV	-- / --	NSV	--
Acenaphthene	6.60 - 995	3 / 16	1,132	OW15-SD16-0.0	125	16.0	3 / 16	7.83	YES
Benzo(k)fluoranthene	26.0 - 3,325	0 / 16	--	--	99	240	-- / --	0.41	NO
Butylbenzylphthalate	420 - 580	0 / 14	--	--	235	63.0	-- / --	3.74	NO
Carbazole	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-5
Screening Statistics - SWMU 15 - Sediment
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Dibenzofuran	420 - 580	0 / 14	--	--	235	540	-- / --	0.44	NO
Diethylphthalate	410 - 580	3 / 15	950	OW15-SD07-7.0	258	200	1 / 15	1.29	**YES**
Dimethyl phthalate	420 - 580	0 / 14	--	--	235	71.0	-- / --	3.31	NO
Fluoranthene	33.0 - 4,220	3 / 16	2,010	OW15-SD02-7.0	325	600	2 / 16	0.54	NO
Fluorene	13.0 - 1,662	1 / 16	66.3	OW15-SD12-5.5	67.8	19.0	1 / 16	3.49	**YES**
Hexachlorobenzene	420 - 580	0 / 14	--	--	235	22.0	-- / --	10.7	NO
Hexachlorobutadiene	420 - 580	0 / 14	--	--	235	11.0	-- / --	21.4	NO
Hexachlorocyclopentadiene	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
Hexachloroethane	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
Isophorone	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
Nitrobenzene	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
Pentachlorophenol	1,000 - 1,500	0 / 16	--	--	578	360	-- / --	1.61	NO
Phenol	410 - 580	0 / 16	--	--	230	420	-- / --	0.55	NO
bis(2-Chloroethoxy)methane	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
bis(2-Chloroethyl)ether	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
n-Nitroso-di-n-propylamine	420 - 580	0 / 14	--	--	235	NSV	-- / --	NSV	NO
n-Nitrosodiphenylamine	420 - 580	0 / 14	--	--	235	28	-- / --	8.41	NO
Volatile Organic Compounds (UG/KG)									
1,1,2,2-Tetrachloroethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
1,1-Dichloroethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
1,1-Dichloroethene	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
1,2-Dichloroethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
1,2-Dichloroethene (total)	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
1,2-Dichloropropane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
2-Butanone	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
2-Hexanone	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
4-Methyl-2-pentanone	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Acetone	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Benzene	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Bromodichloromethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-5
Screening Statistics - SWMU 15 - Sediment
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Bromoform	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Bromomethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Carbon disulfide	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Carbon tetrachloride	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Chlorobenzene	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Chloroethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Chloroform	12.0 - 15.0	0 / 6	--	--	3.75	NSV	-- / --	NSV	NO
Chloromethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Dibromochloromethane	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Ethylbenzene	12.0 - 15.0	2 / 6	61.0	OW15-SD03-2.5	18.8	10	2 / 6	1.88	**YES**
Methylene chloride	12.0 - 15.0	0 / 6	--	--	7.50	NSV	-- / --	NSV	NO
Styrene	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Toluene	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Vinyl chloride	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
Xylene, total	12.0 - 15.0	1 / 6	94.0	OW15-SD03-2.5	21.1	40	1 / 6	0.53	NO
cis-1,3-Dichloropropene	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO
trans-1,3-Dichloropropene	12.0 - 15.0	0 / 6	--	--	6.67	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-6
Screening Statistics - SWMU 15 - Surface Soil
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Inorganics (MG/KG)									
Aluminum	4.60 - 6.50	4 / 4	14,400	OW15-SS06	12,755	50.0	4 / 4	255	**YES**
Chromium	0.11 - 0.15	4 / 4	19.6	OW15-SS07	17.2	0.40	4 / 4	42.9	**YES**
Cyanide	0.20 - 0.28	0 / 4	--	--	0.13	0.06	-- / --	2.10	NO
Iron	3.30 - 4.70	4 / 4	7,470	OW15-SS08	6,673	200	4 / 4	33.4	**YES**
Lead	0.28 - 0.40	4 / 4	118	OW15-SS09	44.1	50.0	1 / 4	0.88	NO
Vanadium	0.14 - 0.20	4 / 4	20.1	OW15-SS06	18.1	2.00	4 / 4	9.06	**YES**
Pesticide/Polychlorinated Biphenyls (UG/KG)									
Aroclor-1254	38.0 - 42.0	1 / 4	450	OW15-SS08	127	100	1 / 4	1.27	**YES**
Aroclor-1260	38.0 - 42.0	1 / 4	420	OW15-SS08	120	100	1 / 4	1.20	**YES**
Endosulfan I	1.90 - 2.10	0 / 4	--	--	1.01	NSV	-- / --	NSV	NO
Endosulfan II	3.80 - 4.20	0 / 4	--	--	2.00	NSV	-- / --	NSV	NO
Endosulfan sulfate	3.80 - 4.20	0 / 4	--	--	2.00	NSV	-- / --	NSV	NO
Heptachlor	1.90 - 2.10	0 / 4	--	--	1.01	NSV	-- / --	NSV	NO
Toxaphene	190 - 210	0 / 4	--	--	101	NSV	-- / --	NSV	NO
Semivolatile Organic Compounds (UG/KG)									
1,2,4-Trichlorobenzene	380 - 4,200	0 / 4	--	--	674	1,270	-- / --	0.53	NO
1,2-Dichlorobenzene	380 - 4,200	0 / 4	--	--	674	100	-- / --	6.74	NO
1,3-Dichlorobenzene	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
1,4-Dichlorobenzene	380 - 4,200	0 / 4	--	--	674	1,280	-- / --	0.53	NO
2,2'-Oxybis(1-chloropropane)	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
2,4,5-Trichlorophenol	950 - 10,000	0 / 4	--	--	1,616	430	-- / --	3.76	NO
2,4,6-Trichlorophenol	380 - 4,200	0 / 4	--	--	674	580	-- / --	1.16	NO
2,4-Dimethylphenol	380 - 4,200	0 / 4	--	--	674	100	-- / --	6.74	NO
2,4-Dinitrotoluene	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
2,6-Dinitrotoluene	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
2-Chloronaphthalene	380 - 4,200	0 / 4	--	--	674	1,033	-- / --	0.65	NO
2-Chlorophenol	380 - 4,200	0 / 4	--	--	674	100	-- / --	6.74	NO
2-Methylnaphthalene	380 - 4,200	1 / 4	700	OW15-SS07	324	NSV	-- / --	NSV	**YES**
2-Methylphenol	380 - 4,200	0 / 4	--	--	674	100	-- / --	6.74	NO
2-Nitroaniline	950 - 10,000	0 / 4	--	--	1,616	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-6
Screening Statistics - SWMU 15 - Surface Soil
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
2-Nitrophenol	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
3,3'-Dichlorobenzidine	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
3-Nitroaniline	950 - 10,000	0 / 4	--	--	1,616	NSV	-- / --	NSV	NO
4,6-Dinitro-2-methylphenol	950 - 10,000	0 / 4	--	--	1,616	NSV	-- / --	NSV	NO
4-Bromophenyl-phenylether	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
4-Chloro-3-methylphenol	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
4-Chloroaniline	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
4-Chlorophenyl-phenylether	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
4-Methylphenol	380 - 4,200	0 / 4	--	--	674	100	-- / --	6.74	NO
4-Nitroaniline	950 - 10,000	0 / 4	--	--	1,616	NSV	-- / --	NSV	NO
4-Nitrophenol	950 - 10,000	0 / 4	--	--	1,616	380	-- / --	4.25	NO
Acenaphthene	420 - 820	3 / 4	33,939	OW15-SS07	9,634	2,500	2 / 4	3.85	**YES**
Acenaphthylene	380 - 4,099	0 / 4	--	--	661	100	-- / --	6.61	NO
Anthracene	380 - 4,200	2 / 4	3,200	OW15-SS07	918	100	1 / 4	9.18	**YES**
Benzo(a)anthracene	38.9 - 380	4 / 4	22,954	OW15-SS07	6,139	100	4 / 4	61.4	**YES**
Benzo(a)pyrene	380 - 4,200	3 / 4	29,000	OW15-SS07	7,479	100	3 / 4	74.8	**YES**
Benzo(b)fluoranthene	380 - 4,200	3 / 4	48,510	OW15-SS06	22,285	100	3 / 4	223	**YES**
Benzo(g,h,i)perylene	380 - 820	3 / 4	203,419	OW15-SS07	51,047	100	3 / 4	510	**YES**
Benzo(k)fluoranthene	380 - 4,200	3 / 4	16,000	OW15-SS07	4,160	100	3 / 4	41.6	**YES**
Butylbenzylphthalate	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
Carbazole	380 - 4,200	2 / 4	2,000	OW15-SS07	612	NSV	-- / --	NSV	**YES**
Chrysene	38.9 - 380	4 / 4	44,087	OW15-SS07	11,695	100	4 / 4	117	**YES**
Di-n-octylphthalate	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
Dibenz(a,h)anthracene	380 - 820	1 / 4	33,753	OW15-SS07	8,587	100	1 / 4	85.9	**YES**
Dibenzofuran	380 - 4,200	1 / 4	830	OW15-SS07	356	NSV	-- / --	NSV	**YES**
Fluoranthene	380 - 4,135	4 / 4	279,888	OW15-SS07	97,643	100	4 / 4	976	**YES**
Fluorene	380 - 1,615	1 / 4	1,561,141	OW15-SS07	390,577	1,700	1 / 4	230	**YES**
Hexachlorobenzene	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
Hexachlorobutadiene	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
Hexachlorocyclopentadiene	380 - 4,200	0 / 4	--	--	674	1,000	-- / --	0.67	NO
Hexachloroethane	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-6
Screening Statistics - SWMU 15 - Surface Soil
NAS Oceana, Virginia Beach, Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	COPC?
Indeno(1,2,3-cd)pyrene	380 - 4,200	3 / 4	16,000	OW15-SS07	4,173	100	3 / 4	41.7	**YES**
Isophorone	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
Naphthalene	380 - 4,200	1 / 4	2,700	OW15-SS07	824	100	1 / 4	8.24	**YES**
Nitrobenzene	380 - 4,200	0 / 4	--	--	674	2,260	-- / --	0.30	NO
Pentachlorophenol	950 - 10,000	0 / 4	--	--	1616	3,000	-- / --	0.54	NO
Phenanthrene	200 - 380	3 / 4	16,279	OW15-SS07	4,605	100	3 / 4	46.0	**YES**
Phenol	380 - 4,200	0 / 4	--	--	674	1,880	-- / --	0.36	NO
Pyrene	20.0 - 4,200	4 / 4	21,000	OW15-SS07	5,519	100	3 / 4	55.2	**YES**
bis(2-Chloroethoxy)methane	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
bis(2-Chloroethyl)ether	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
bis(2-Ethylhexyl)phthalate	380 - 4,200	0 / 4	--	--	631	NSV	-- / --	NSV	NO
n-Nitroso-di-n-propylamine	380 - 4,200	0 / 4	--	--	674	NSV	-- / --	NSV	NO
n-Nitrosodiphenylamine	380 - 4,200	0 / 4	--	--	674	1,090	-- / --	0.62	NO
Volatile Organic Compounds (UG/KG)									
1,1-Dichloroethene	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
2-Butanone	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
2-Hexanone	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
Acetone	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
Bromomethane	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
Carbon disulfide	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
Chloroethane	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
Chloromethane	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO
Dibromochloromethane	11.0 - 12.0	0 / 4	--	--	5.875	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotients based on reporting limits

Table 5-7
Summary of Hazard Quotients for Food Web Exposures - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical	Short-tailed shrew		Deer mouse		Meadow vole		Raccoon		Mink		Red fox	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals												
Aluminum	10.17	1.02	0.93	0.09	0.93	0.09	0.60	0.06	6.26	0.63	0.29	0.03
Arsenic	0.42	0.04	0.07	<0.01	0.05	<0.01	0.12	0.01	0.11	0.01	0.02	<0.01
Barium	0.43	0.11	0.09	0.02	0.10	0.03	0.11	0.03	0.33	0.09	0.03	<0.01
Chromium	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Iron	1.91	0.19	0.16	0.02	0.19	0.02	1.98	0.20	6.43	0.64	0.16	0.02
Lead	0.19	0.02	0.03	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Mercury	0.13	0.03	0.03	<0.01	0.02	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01
Vanadium	1.24	0.12	0.11	0.01	0.13	0.01	1.02	0.10	3.31	0.33	0.12	0.01
Zinc	0.02	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02	<0.01
Pesticides/PCBs												
Aroclor-1221	0.19	0.02	0.04	<0.01	<0.01	<0.01	0.02	<0.01	0.18	0.02	0.01	<0.01
Aroclor-1232	0.10	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	<0.01	<0.01	<0.01
Aroclor-1242	0.10	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	<0.01	<0.01	<0.01
Aroclor-1248	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor-1254	0.61	0.06	0.11	0.01	0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.01	<0.01
Aroclor-1260	0.57	0.06	0.11	0.01	0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.01	<0.01
Semivolatile Organics												
Benzo(a)anthracene	0.19	0.02	0.03	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Benzo(a)pyrene	0.27	0.03	0.04	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Benzo(b)fluoranthene	0.60	0.06	0.08	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Chrysene	0.51	0.05	0.08	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01
Dibenz(a,h)anthracene	0.41	0.04	0.06	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
Fluorene	0.08	<0.01	0.02	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Hexachlorobenzene	0.06	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pentachlorophenol	0.21	0.02	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 5-7
Summary of Hazard Quotients for Food Web Exposures - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical	American robin		Marsh wren		American kestrel		Great blue heron		Mallard	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals										
Aluminum	0.61	0.06	1.83	0.18	0.46	0.05	19.26	1.93	0.24	0.02
Arsenic	<0.01	<0.01	0.12	0.04	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Barium	<0.01	<0.01	0.05	0.03	<0.01	<0.01	0.04	0.02	<0.01	<0.01
Chromium	0.23	0.05	0.59	0.12	0.27	0.05	0.13	0.03	0.05	0.01
Cobalt	0.03	<0.01	0.49	0.05	0.02	<0.01	0.39	0.04	0.02	<0.01
Iron	0.32	0.03	21.56	2.16	0.22	0.02	17.20	1.72	0.73	0.07
Lead	0.56	0.06	0.91	0.09	0.16	0.02	0.04	<0.01	0.06	<0.01
Mercury	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	2.18	0.22	0.09	<0.01
Vanadium	<0.01	<0.01	0.41	0.04	<0.01	<0.01	0.33	0.03	0.01	<0.01
Zinc	0.13	0.01	0.31	0.03	0.14	0.02	0.04	<0.01	0.04	<0.01
Pesticides/PCBs										
Aroclor-1221	0.01	<0.01	0.05	<0.01	0.01	<0.01	0.16	0.02	<0.01	<0.01
Aroclor-1232	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01
Aroclor-1242	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01
Aroclor-1248	0.02	<0.01	0.05	<0.01	0.02	<0.01	0.19	0.02	<0.01	<0.01
Aroclor-1254	0.10	<0.01	0.05	<0.01	0.10	0.01	0.19	0.02	<0.01	<0.01
Aroclor-1260	0.09	<0.01	0.05	<0.01	0.10	<0.01	0.19	0.02	<0.01	<0.01
Semivolatile Organics										
Benzo(a)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	0.15	0.01	<0.01	<0.01	0.09	<0.01	<0.01	<0.01	<0.01	<0.01
Hexachlorobenzene	0.49	0.05	0.67	0.07	0.51	0.05	0.52	0.05	0.03	<0.01
Pentachlorophenol	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 5-8
Summary of COPCs - SWMU 15
NAS Oceana, Virginia Beach, VA

	Groundwater				Surface Water				Sediment				Surface Soil				Food Web		
Chemical	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	Receptor	Endpoint	Mean HQ
Detected Chemicals With Screening Values																			
2-Methylnaphthalene									1/14	1/14	3.57	3.32							
Acenaphthene									3/16	3/16	70.8	7.83	3/4	2/4	13.6	3.85			
Aluminum	2/7	2/7	6.72	2.33	5/5	5/5	2.20	1.48					4/4	4/4	288	255	Shrew	NOAEL	10.2
																	Shrew	LOAEL	1.02
																	Mink	NOAEL	6.26
																	Marsh wren	NOAEL	1.83
																	Great blue heron	NOAEL	19.3
																	Great blue heron	LOAEL	1.93
Anthracene													2/4	1/4	32	9.18			
Aroclor-1254													1/4	1/4	4.50	1.27			
Aroclor-1260													1/4	1/4	4.20	1.20			
Benzene	5/7	1/7	6.50	1.06															
Benzo(a)anthracene													4/4	4/4	230	61.4			
Benzo(a)pyrene													3/4	3/4	290	74.8			
Benzo(b)fluoranthene													3/4	3/4	485	223			
Benzo(g,h,i)perylene													3/4	3/4	2,034	510			
Benzo(k)fluoranthene													3/4	3/4	160	41.6			
Carbon disulfide	2/7	2/7	97	16.1															
Chromium													4/4	4/4	49.0	42.9			
Chrysene													4/4	4/4	441	117			
Cyanide									5/16	5/16	12.0	3.12							
Dibenz(a,h)anthracene													1/4	1/4	338	86			
Diethylphthalate									3/15	1/15	4.75	1.29							
Ethylbenzene									2/6	2/6	6.10	1.88							
Fluoranthene													4/4	4/4	2,799	976			
Fluorene									1/16	1/16	3.49	3.49	1/4	1/4	918	230			
Indeno(1,2,3-cd)pyrene													3/4	3/4	160	41.7			
Iron	7/7	7/7	48.1	22.9									4/4	4/4	37.4	33.4	Shrew	NOAEL	1.91
																	Raccoon	NOAEL	1.98
																	Mink	NOAEL	6.43
																	Marsh wren	NOAEL	21.6
																	Marsh wren	LOAEL	2.16
																	Great blue heron	NOAEL	17.2
																	Great blue heron	LOAEL	1.72
Manganese	7/7	4/7	4.08	1.46															

FOD - Frequency of Detection
FOE - Frequency of Exceedence

Table 5-8
Summary of COPCs - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater				Surface Water				Sediment				Surface Soil				Food Web		
	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum HQ	Mean HQ	Receptor	Endpoint	Mean HQ
Mercury																	Great blue heron	NOAEL	2.18
Naphthalene													1/4	1/4	27.0	8.24			
Phenanthrene													3/4	3/4	163	46			
Pyrene													4/4	3/4	210	55			
Vanadium													4/4	4/4	10.1	9.06	Shrew	NOAEL	1.24
																	Raccoon	NOAEL	1.02
																	Mink	NOAEL	3.31
Xylenes, total	2/7	1/7	6.78	1.17															
Detected Chemicals Without Screening Values																			
2-Methylnaphthalene	1/7	--	4.0 ug/L	--									1/4	--	700 ug/kg	324 ug/kg			
Benzo(g,h,i)perylene					1/5	--	1.86 ug/L	0.45 ug/L											
Beryllium									16/16	--	0.98 mg/kg	0.39 mg/kg							
Carbazole													2/4	--	2000 ug/kg	612 ug/kg			
Chrysene	5/7	--	0.06 ug/L	--	3/5	--	0.04 ug/L	0.02 ug/L											
Dibenzofuran													1/4	--	830 ug/kg	356 ug/kg			
Indeno(1,2,3-cd)pyrene					1/5	--	0.10 ug/L	--											
Methane	7/7	--	3200 ug/L	468 ug/L															
Pyrene	4/7	--	0.01 ug/L	--	1/5	--	0.01 ug/L	0.005 ug/L											
Thallium									1/7	--	0.87 mg/kg	0.47 mg/kg							

FOD - Frequency of Detection
FOE - Frequency of Exceedence

Table 5-9
Summary Statistics - SWMU 15 - Groundwater (Upgradient Wells)
NAS Oceana, Virginia Beach, VA

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Inorganics (UG/L)						
Ferric iron	500 - 500	0 / 1	--	--	250	0
Ferrous iron	500 - 500	0 / 1	--	--	250	0
Manganese	500 - 500	0 / 1	--	--	250	0
Volatile Organic Compounds (UG/L)						
1,2-Dibromoethane	2.00 - 2.00	0 / 1	--	--	1.00	0
Benzene	2.00 - 2.00	0 / 1	--	--	1.00	0
Bromomethane	2.00 - 2.00	0 / 1	--	--	1.00	0
Chlorobenzene	2.00 - 2.00	0 / 1	--	--	1.00	0
Chloroethane	2.00 - 2.00	0 / 1	--	--	1.00	0
Methane	0.02 - 0.02	1 / 1	2.50	OW15-MW13-R02	2.50	0
Styrene	2.00 - 2.00	0 / 1	--	--	1.00	0
m- and p-Xylene	2.00 - 2.00	0 / 1	--	--	1.00	0
o-Xylene	2.00 - 2.00	0 / 1	--	--	1.00	0

[1] One-half of the reporting limit was used for non-detected samples when calculating the mean.

Table 5-10
Comparison of SWMU 15 Groundwater COPC Concentrations to Upgradient Concentrations
NAS Oceana, Virginia Beach, VA

Chemical	On-Site/Downgradient			Upgradient			
	Frequency of Detection	Maximum	Arithmetic Mean	Maximum	Arithmetic Mean	Exceeds Maximum?	Exceeds Mean?
Inorganics (ug/L)							
Aluminum	2 / 7	585	202	--	--	--	--
Iron	7 / 7	15,400	7,334	--	--	--	--
Manganese	7 / 7	490	175	--	250	YES	NO
Organics (ug/L)							
2-Methylnaphthalene	1 / 7	4.00	--	--	--	--	--
Chrysene	5 / 7	0.06	--	--	--	--	--
Pyrene	4 / 7	0.01	--	--	--	--	--
Benzene	5 / 7	3,444	564	--	1.00	YES	YES
Carbon disulfide	2 / 7	194	32.2	--	--	--	--
Methane	7 / 7	3,200	968	2.50	2.50	YES	YES
Xylene, total	2 / 7	882	152	--	1.00	YES	YES

Table 5-11
Comparison of SWMU 15 Surface Soil COPC Concentrations to Background Concentrations
NAS Oceana, Virginia Beach, VA

Chemical	On-Site			Background			
	Frequency of	Maximum	Arithmetic Mean	Maximum	Arithmetic Mean	Exceeds Maximum?	Exceeds Mean?
Inorganics (mg/kg)							
Aluminum	4 / 4	14,400	12,755	100,000	66,000	NO	NO
Chromium	4 / 4	19.6	17.2	19.5	15.7	NO	NO
Iron	4 / 4	7,470	6,673	100,000	25,000	NO	NO
Vanadium	4 / 4	20.1	18.1	500	76	NO	NO
Organics (ug/kg)							
Aroclor-1254	1 / 4	450	127	--	--	--	--
Aroclor-1260	1 / 4	420	120	--	--	--	--
2-Methylnaphthalene	1 / 4	700	324	26	23	YES	YES
Acenaphthene	3 / 4	33,939	9,634	26	23	YES	YES
Anthracene	2 / 4	3,200	918	3.9	2.0	YES	YES
Benzo(a)anthracene	4 / 4	22,954	6,139	220	56	YES	YES
Benzo(a)pyrene	3 / 4	29,000	7,479	340	83	YES	YES
Benzo(b)fluoranthene	3 / 4	48,510	22,285	270	63	YES	YES
Benzo(g,h,i)perylene	3 / 4	203,419	51,047	180	48	YES	YES
Benzo(k)fluoranthene	3 / 4	16,000	4,160	270	56	YES	YES
Carbazole	2 / 4	2,000	612	--	--	--	--
Chrysene	4 / 4	44,087	11,695	320	79	YES	YES
Dibenz(a,h)anthracene	1 / 4	33,753	8,587	6.2	5.0	YES	YES
Dibenzofuran	1 / 4	830	356	--	--	--	--
Fluoranthene	4 / 4	279,888	97,643	580	136	YES	YES
Fluorene	1 / 4	1,561,141	390,577	5.2	5.0	YES	YES
Indeno(1,2,3-cd)pyrene	3 / 4	16,000	4,173	97	32	YES	YES
Naphthalene	1 / 4	2,700	824	26	23	YES	YES
Phenanthrene	3 / 4	16,279	4,605	200	48	YES	YES
Pyrene	4 / 4	21,000	5,519	430	106	YES	YES

Table 8-1 Summary of Ecological Risk - SWMU 1 *NAS Oceana, Virginia Beach, VA*						
	Groundwater	Surface Water	Sediment	Surface Soil	Food Web	
Chemical	**Mean HQ**	**Mean HQ**	**Mean HQ**	**Mean HQ**	**Receptor**	**Mean HQ**
Detected Chemicals With Screening Values						
Metals						
Aluminum		5.52		240	Shrew	9.58
Chromium				40		
Iron		4.01		44	Shrew	2.52
					Mink	1.66
					Marsh wren	5.56
					Great blue heron	4.43
Mercury				1.05		
Vanadium				8.35	Shrew	1.14
Semivolatile Organics						
Benzo(a)anthracene				1.03		
Benzo(a)pyrene				1.01		
Benzo(b)fluoranthene				1.04		
Chrysene				1.07		
Fluoranthene				1.76		
Indene(1,2,3-cd)pyrene				1.07		
Pyrene				1.24		

HQ - Hazard Quotient

Table 8-2
Summary of Ecological Risk - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical	Groundwater Mean HQ	Surface Water Mean HQ	Sediment Mean HQ	Surface Soil Mean HQ	Food Web Receptor	Food Web Mean HQ [1]
Detected Chemicals With Screening Values						
Metals						
Aluminum	2.33	1.48		255	Shrew	10.2
					Shrew	1.02 (LOAEL)
					Mink	6.26
					Marsh wren	1.83
					Great blue heron	19.3
					Great blue heron	1.93 (LOAEL)
Chromium				42.9		
Cyanide			3.12			
Iron	22.9			33.4	Shrew	1.91
					Raccoon	1.98
					Mink	6.43
					Marsh wren	21.6
					Marsh wren	2.16 (LOAEL)
					Great blue heron	17.2
					Great blue heron	1.72 (LOAEL)
Manganese	1.46					
Mercury					Great blue heron	2.18
Vanadium				9.06	Shrew	1.24
					Raccoon	1.02
					Mink	3.31
PCBs						
Aroclor-1254				1.27		
Aroclor-1260				1.20		
Semivolatile Organics						
2-Methylnaphthalene			3.32			
Acenaphthene			7.83	3.85		
Anthracene				9.18		
Benzo(a)anthracene				61.4		
Benzo(a)pyrene				74.8		
Benzo(b)fluoranthene				223		
Benzo(g,h,i)perylene				510		
Benzo(k)fluoranthene				41.6		
Chrysene				117		
Dibenz(a,h)anthracene				86		
Diethylphthalate			1.29			
Fluoranthene				976		
Fluorene			3.49	230		
Indeno(1,2,3-cd)pyrene				41.7		
Naphthalene				8.24		
Phenanthrene				46		
Pyrene				55		
Volatile Organics						
Benzene	1.06					
Carbon disulfide	16.1					
Ethylbenzene			1.88			
Xylenes, total	1.17					

1 - Based upon the NOAEL unless otherwise specified
HQ - Hazard Quotient

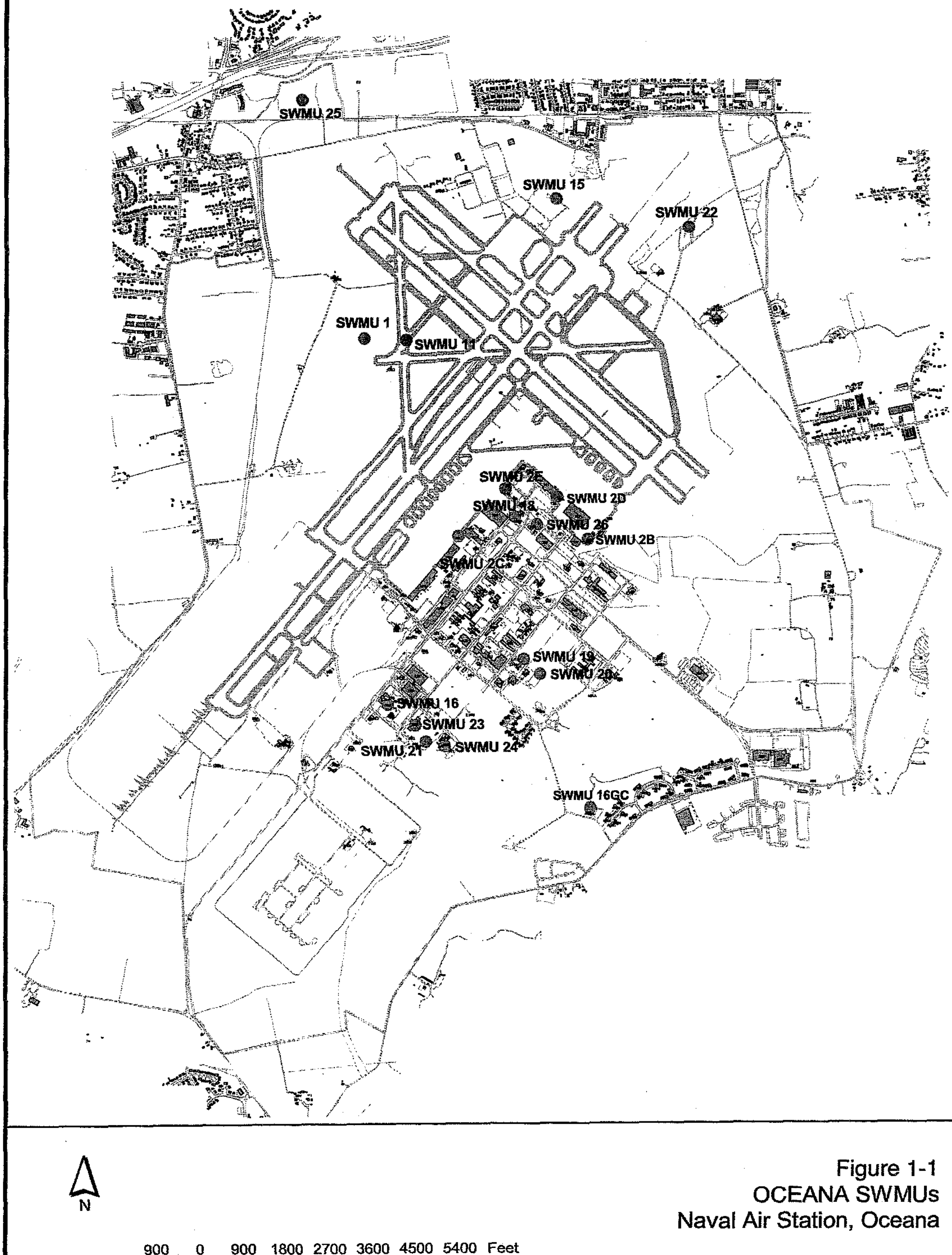


Figure 1-1
OCEANA SWMUs
Naval Air Station, Oceana

CH2MHILL

File Path: c:\18gis\oceana_0400.apr

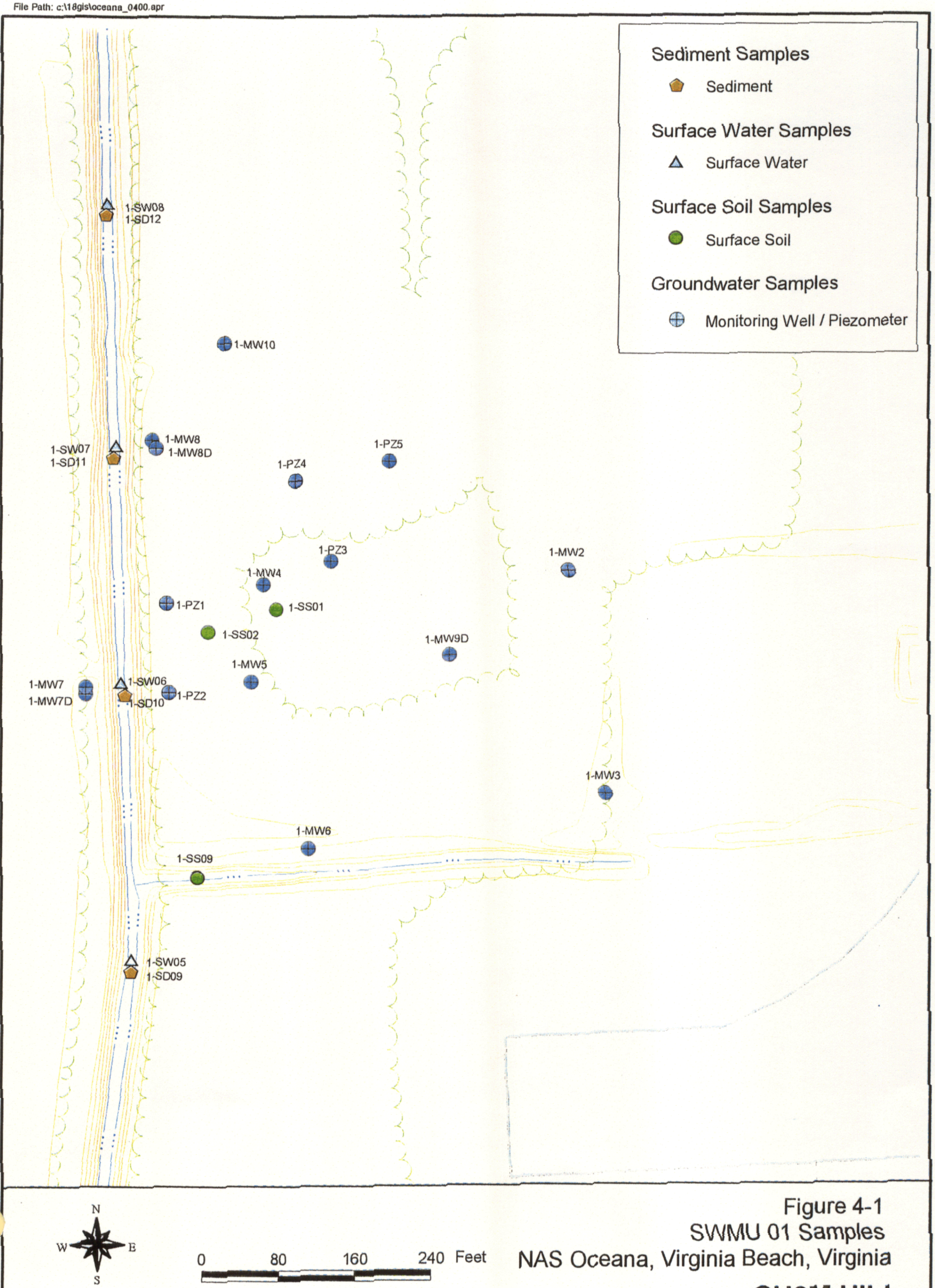
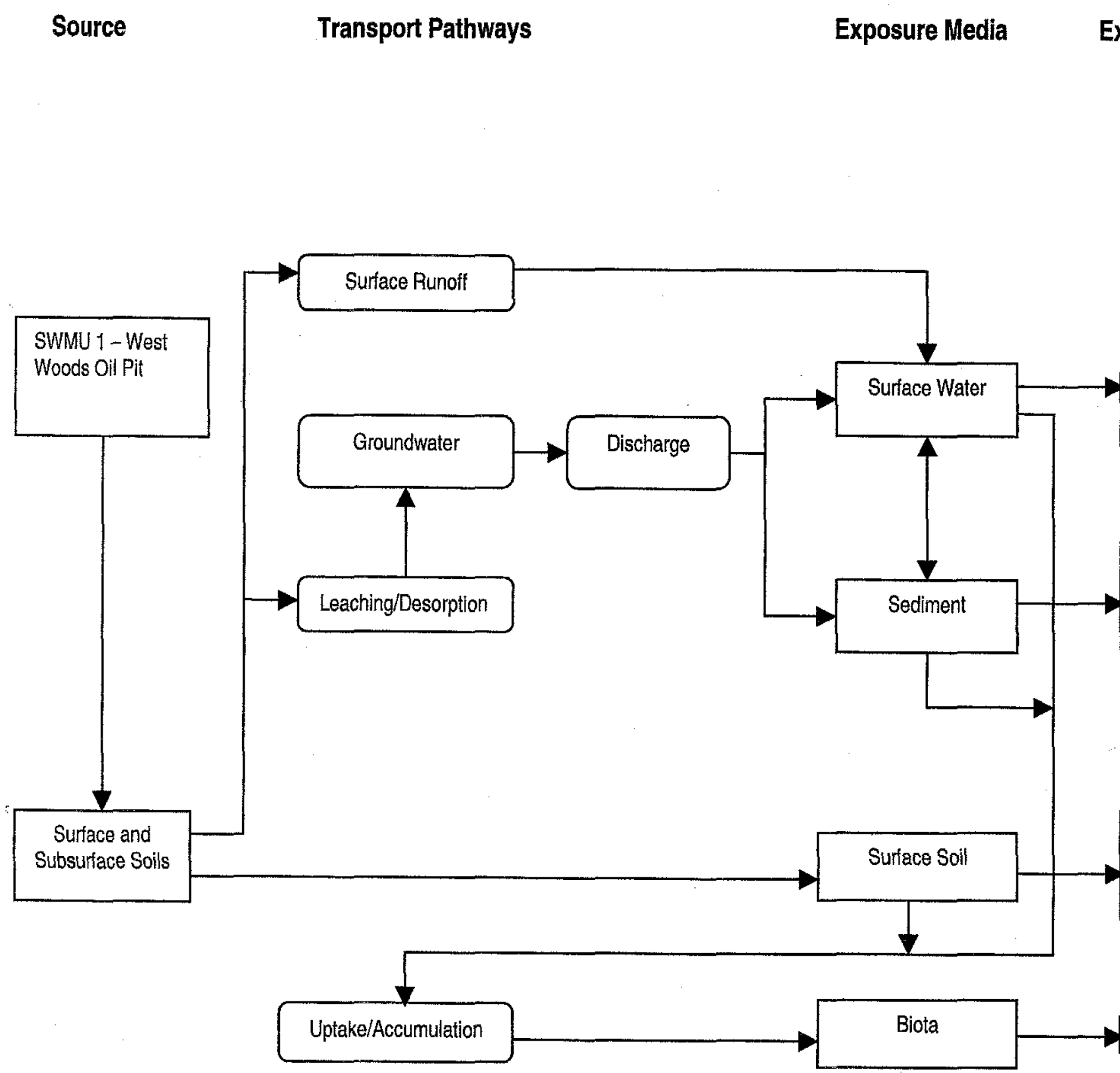


Figure 4-1
SWMU 01 Samples
NAS Oceana, Virginia Beach, Virginia

CH2M HILL

00556E 014



Exposure Media	Exposure Route	Aquatic							Terrestrial					
		Invertebrates	Plants	Fish	Amphibians	Reptiles	Birds	Mammals	Invertebrates	Plants	Amphibians	Reptiles	Birds	Mammals
Surface Water	Ingestion			*	*	*	•	•			*	*	•	•
	Direct Contact	•	•	•	•	*	*	*						
Sediment	Ingestion	•		*	*	*	•	•						
	Direct Contact	•		•	•	*	*	*						
	Root Uptake		•											
Surface Soil	Ingestion								•		*	*	•	•
	Direct Contact								•		*	*	*	*
	Root Uptake									•				
Biota	Ingestion	*		•	*	*	•	•	*		*	*	•	•

**FIGURE 4-2. CONCEPTUAL MODEL
NAS OCEANA – SWMU 1**

• - Exposure route evaluated quantitatively
* - Exposure route not evaluated quantitatively (see text)

File Path: c:\18gis\oceana_0400.apr

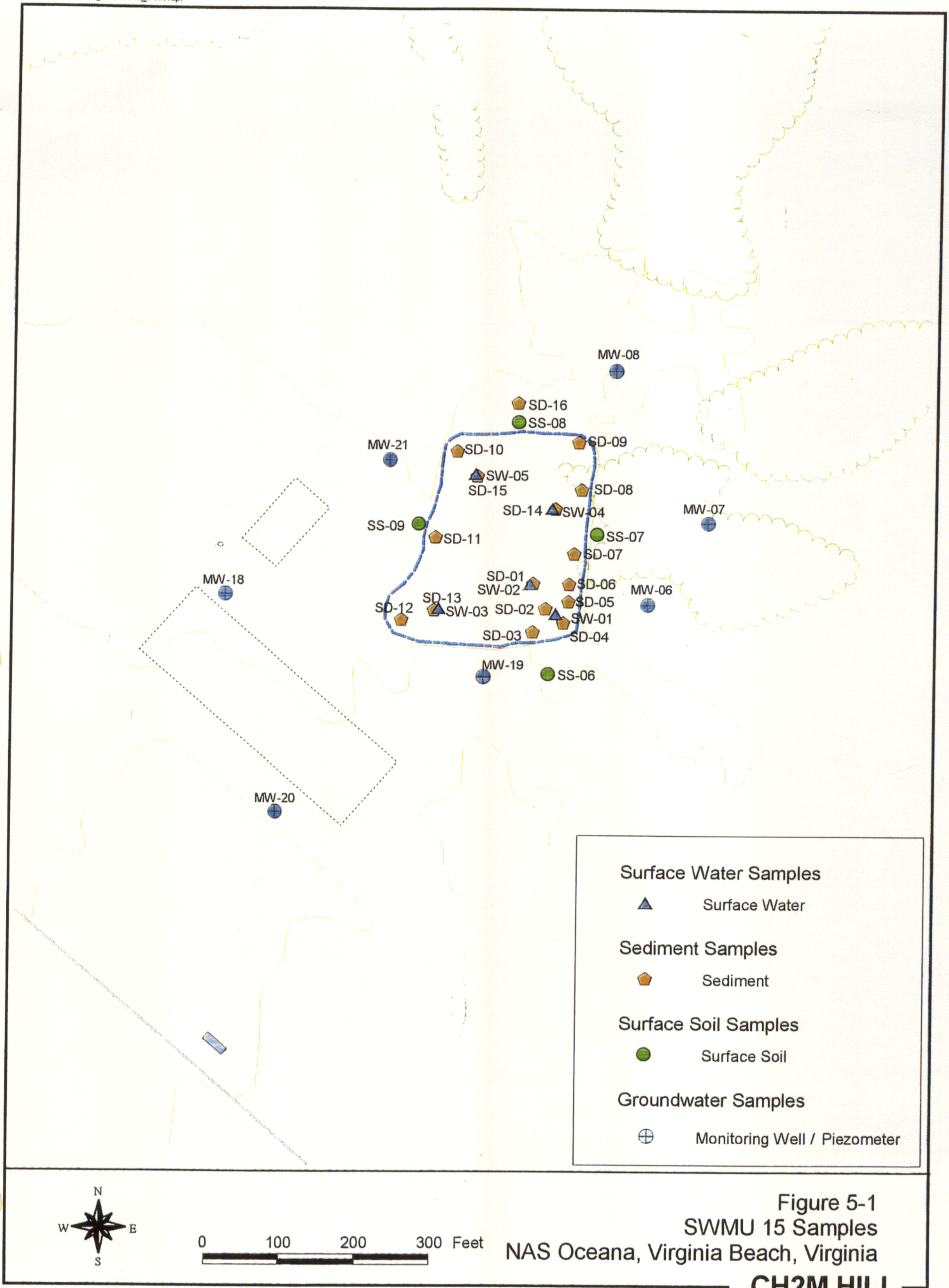
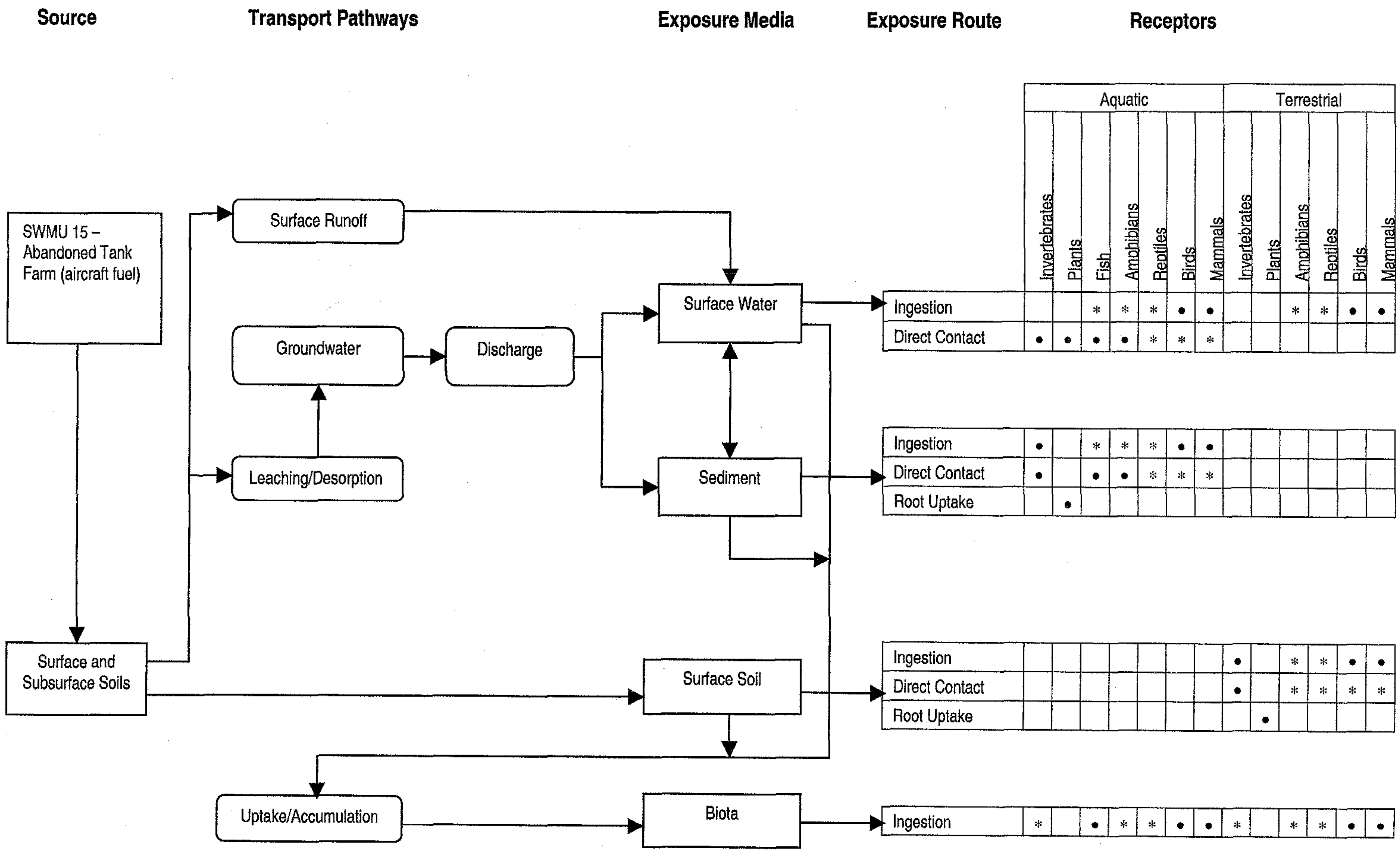


Figure 5-1
SWMU 15 Samples
NAS Oceana, Virginia Beach, Virginia

CH2M HILL

00555 6024



Exposure Media	Exposure Route	Aquatic Invertebrates	Aquatic Plants	Aquatic Fish	Aquatic Amphibians	Aquatic Reptiles	Aquatic Birds	Aquatic Mammals	Terrestrial Invertebrates	Terrestrial Plants	Terrestrial Amphibians	Terrestrial Reptiles	Terrestrial Birds	Terrestrial Mammals
Surface Water	Ingestion			*	*	*	•	•			*	*	•	•
	Direct Contact	•	•	•	•	*	*	*						
Sediment	Ingestion	•		*	*	*	•	•						
	Direct Contact	•		•	•	*	*	*						
	Root Uptake		•											
Surface Soil	Ingestion								•		*	*	•	•
	Direct Contact								•		*	*	*	*
	Root Uptake									•				
Biota	Ingestion	*		•	*	*	•	•	*		*	*	•	•

• - Exposure route evaluated quantitatively
* - Exposure route not evaluated quantitatively (see text)

FIGURE 5-2. CONCEPTUAL MODEL
NAS OCEANA – SWMU 15

Appendix A
Analytical Data

SUMMARY OF DATA QUALIFIERS AND OTHER CODES

NS	Not Sampled
B	Analyte not detected above associated blank
J	Reported value is estimated
K	Reported value may be biased high
L	Reported value may be biased low
NJ	Estimated; tentative identification
U	Analyte not detected
UJ	Analyte not detected; quantitation limit is estimated
UL	Analyte not detected; quantitation limit is probably higher

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-MW02-R01		OW01-MW03-R01		OW01-MW04-R01		OW01-MW04P-R01		OW01-MW05-R01		OW01-MW06-R01	
Volatile Organic Compounds (UG/L)												
1,1,1,2-Tetrachloroethane	1	U	1	U	5	UL	10	U	1	U	1	U
1,1,1-Trichloroethane	1	U	1	U	5	UL	10	U	1	U	1	U
1,1,2,2-Tetrachloroethane	1	U	1	U	5	UL	10	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	5	UL	10	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	5	UL	10	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	5	UL	10	U	1	U	1	U
1,1-Dichloropropene	1	U	1	U	5	UL	10	U	1	U	1	U
1,2,3-Trichlorobenzene	1	U	1	U	5	UL	10	U	1	U	1	U
1,2,3-Trichloropropane	1	U	1	U	5	UL	10	U	1	U	1	U
1,2,4-Trichlorobenzene	1	U	1	U	5	UL	10	U	1	U	1	U
1,2,4-Trimethylbenzene	1	U	1	U	5	UL	10	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	5	UL	10	U	1	U	1	U
1,2-Dichlorobenzene	1	U	1	U	5	UL	10	U	1	U	1	U
1,2-Dichloroethane	1	U	1	U	5	UL	10	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	5	UL	10	U	1	U	1	U
1,3,5-Trimethylbenzene	1	U	1	U	5	L	10	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	5	UL	10	U	1	U	1	U
1,3-Dichloropropane	1	U	1	U	5	UL	10	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	5	UL	10	U	1	U	1	U
2,2-Dichloropropane	1	U	1	U	5	UL	10	U	1	U	1	U
Benzene	1	U	1	U	3	L	10	U	1	J	1	U
Bromobenzene	1	U	1	U	5	UL	10	U	1	U	1	U
Bromochloromethane	1	U	1	U	5	UL	10	U	1	U	1	U
Bromodichloromethane	1	U	1	U	5	UL	10	U	1	U	1	U
Bromoform	1	U	1	U	5	UL	10	U	1	U	1	U
Bromomethane	1	U	1	U	5	UL	10	U	1	U	1	U
Carbon tetrachloride	1	U	1	U	5	UL	10	U	1	U	1	U
Chlorobenzene	1	U	1	U	5	UL	10	U	1	U	1	U
Chloroethane	1	U	1	U	5	UL	10	U	1	U	1	U
Chloroform	1	U	1	U	5	B	9	B	1	U	1	U
Chloromethane	1	U	1	U	5	UL	10	U	1	U	1	U
Cumene	1	U	1	U	5	L	7	J	1		1	U
Dibromochloromethane	1	U	1	U	5	UL	10	U	1	U	1	U

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-MW02-R01		OW01-MW03-R01		OW01-MW04-R01		OW01-MW04P-R01		OW01-MW05-R01		OW01-MW06-R01	
Dibromomethane	1	U	1	U	5	UL	10	U	1	U	1	U
Dichlorodifluoromethane	1	U	1	U	5	UL	10	U	1	U	1	U
Ethylbenzene	1	U	1	U	5	UL	10	U	1	U	1	U
Hexachlorobutadiene	1	U	1	U	5	UL	10	U	1	U	1	U
Methylene chloride	1	U	1	U	4	B	8	B	1	U	1	B
Styrene	1	U	1	U	5	UL	10	U	1	U	1	U
Tetrachloroethene	1	U	1	U	5	UL	10	U	1	U	1	U
Toluene	1	U	1	U	5	UL	10	U	1	U	1	U
Trichloroethene	1	J	1	U	5	UL	10	U	1	U	1	U
Trichlorofluoromethane	1	U	1	U	5	UL	10	U	1	U	1	U
Vinyl chloride	1	U	1	U	5	UL	10	U	1	U	1	U
Xylene, total	1	U	1	U	9	L	12		2		1	U
cis-1,2-Dichloroethene	1	U	1	U	5	UL	10	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	5	UL	10	U	1	U	1	U
n-Butylbenzene	1	U	1	U	5	UL	10	U	1	U	1	U
n-Propylbenzene	1	U	1	U	7	L	10		1	U	1	U
o-Chlorotoluene	1	U	1	U	5	UL	10	U	1	U	1	U
o-Xylene	1	U	1	U	5	UL	10	U	1	U	1	U
p-Chlorotoluene	1	U	1	U	5	UL	10	U	1	U	1	U
p-Isopropyltoluene	1	U	1	U	5	UL	10	U	1	U	1	U
sec-Butylbenzene	1	U	1	U	5	UL	10	U	1	U	1	U
tert-Butylbenzene	1	U	1	U	5	UL	10	U	1	U	1	U
trans-1,2-Dichloroethene	1	U	1	U	5	UL	10	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	5	UL	10	U	1	U	1	U
Semivolatile Organic Compounds (UG/L)												
Acenaphthene	0.22	U	0.2	U	36	B	24	B	14	B	0.21	U
Acenaphthylene	1.1	U	1	U	110	U	110	U	21	U	1	U
Anthracene	0.064	B	0.074	B	9.2	B	3.5	B	3.7	B	0.1	U
Benzo(a)anthracene	0.011	U	0.01	U	1.1	U	1.1	U	0.21	U	0.01	U
Benzo(a)pyrene	0.11	U	0.1	U	11	U	11	U	2.1	U	0.1	U
Benzo(b)fluoranthene	0.43	U	0.4	U	42	U	43	U	8.3	U	0.42	U
Benzo(g,h,i)perylene	0.22	U	0.2	U	21	U	22	U	4.2	U	0.21	U
Benzo(k)fluoranthene	0.86	U	0.81	U	84	U	86	U	17	U	0.84	U
Chrysene	0.011	U	0.01	U	1.1	U	1.1	U	0.21	U	0.01	U
Dibenz(a,h)anthracene	0.22	U	0.2	U	21	U	22	U	4.2	U	0.21	U

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-MW02-R01		OW01-MW03-R01		OW01-MW04-R01		OW01-MW04P-R01		OW01-MW05-R01		OW01-MW06-R01	
Fluoranthene	1.1	U	2.1	B	530	B	180	B	180	B	1	U
Fluorene	0.43	U	0.4	U	180	B	120	B	32	B	0.42	U
Indeno(1,2,3-cd)pyrene	0.43	U	0.4	U	42	U	43	U	8.3	U	0.42	U
Naphthalene	1	U	1	U	179	L	208		58		1	U
Phenanthrene	0.061	B	0.018	B	18	B	7.1	B	7.8	B	0.012	B
Pyrene	0.003	J	0.005		0.23	J	0.54	U	0.037	J	0.005	

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-MW07-R01		OW01-MW07D-R01		OW01-MW08-R01		OW01-MW08D-R01		OW01-PZ01-R01		OW01-PZ02-R01	
Volatile Organic Compounds (UG/L)												
1,1,1,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
1,2,3-Trichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2,3-Trichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
1,2,4-Trichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2,4-Trimethylbenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
1,3,5-Trimethylbenzene	1	U	1	U	1	U	1	U	1	U	3	
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
2,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U	1	U
Benzene	1	U	1	U	1	J	1	U	1	U	1	
Bromobenzene	1	U	1	U	1	U	1	U	1	U	1	U
Bromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Bromoform	1	U	1	U	1	U	1	U	1	U	1	U
Bromomethane	1	U	1	U	1	U	1	U	1	U	1	U
Carbon tetrachloride	1	U	1	U	1	U	1	U	1	U	1	U
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U	1	U	1	U	1	U
Chloroform	1	U	1	U	1	U	1	U	1	U	1	U
Chloromethane	1	U	1	U	1	U	1	U	1	U	1	U
Cumene	1	U	1	U	1	U	1	U	1	U	3	
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U	1	U

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-MW07-R01		OW01-MW07D-R01		OW01-MW08-R01		OW01-MW08D-R01		OW01-PZ01-R01		OW01-PZ02-R01	
Dibromomethane	1	U	1	U	1	U	1	U	1	U	1	U
Dichlorodifluoromethane	1	U	1	U	1	U	1	U	1	U	1	U
Ethylbenzene	1	U	1	U	1	U	1	U	1	U	1	U
Hexachlorobutadiene	1	U	1	U	1	U	1	U	1	U	1	U
Methylene chloride	1	B	1	B	1	B	1	B	1	B	1	B
Styrene	1	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Toluene	1	U	1	U	1	U	1	U	1	U	1	U
Trichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
Trichlorofluoromethane	1	U	1	U	1	U	1	U	1	U	1	U
Vinyl chloride	1	U	1	U	1	U	1	U	1	U	1	U
Xylene, total	1	U	1	U	1	U	1	U	1	U	1	J
cis-1,2-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
n-Butylbenzene	1	U	1	U	1	U	1	U	1	U	1	U
n-Propylbenzene	1	U	1	U	1	U	1	U	1	U	4	
o-Chlorotoluene	1	U	1	U	1	U	1	U	1	U	1	U
o-Xylene	1	U	1	U	1	U	1	U	1	U	1	U
p-Chlorotoluene	1	U	1	U	1	U	1	U	1	U	1	U
p-Isopropyltoluene	1	U	1	U	1	U	1	U	1	U	1	U
sec-Butylbenzene	1	U	1	U	1	U	1	U	2		4	
tert-Butylbenzene	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,2-Dichloroethene	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U	1	U
Semivolatile Organic Compounds (UG/L)												
Acenaphthene	0.21	U	0.21	U	0.2	U	1	U	0.13	J	0.15	J
Acenaphthylene	1	U	1	U	1	U	5	U	1	U	1.1	U
Anthracene	0.1	U	0.92	B	0.1	U	0.36	B	0.22	B	0.85	B
Benzo(a)anthracene	0.01	U	0.01	U	0.01	U	0.23		0.01	U	0.011	U
Benzo(a)pyrene	0.1	U	0.1	U	0.1	U	0.5	U	0.2		0.11	U
Benzo(b)fluoranthene	0.42	U	0.42	U	0.41	U	2	U	0.42	U	0.42	U
Benzo(g,h,i)perylene	0.21	U	0.21	U	0.2	U	1	U	0.21	U	0.21	U
Benzo(k)fluoranthene	0.84	U	0.83	U	0.82	U	4	U	0.84	U	0.85	U
Chrysene	0.01	U	0.01	U	0.01	U	0.05	U	0.01	U	0.011	U
Dibenz(a,h)anthracene	0.21	U	0.21	U	0.2	U	1	U	0.21	U	0.21	U

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-MW07-R01		OW01-MW07D-R01		OW01-MW08-R01		OW01-MW08D-R01		OW01-PZ01-R01		OW01-PZ02-R01	
Fluoranthene	1	U	2.4		1	U	6.5		1	U	6.2	
Fluorene	0.42	U	0.42	U	0.41	U	2	U	0.42	U	0.42	U
Indeno(1,2,3-cd)pyrene	0.42	U	0.42	U	0.41	U	2	U	0.42	U	0.42	U
Naphthalene	1	U	1	U	1	U	1	U	1	U	18	
Phenanthrene	0.014	B	0.35		0.016	B	0.25	U	0.052	U	0.053	U
Pyrene	0.002	J	0.005	U	0.005	U	0.01	J	0.003	J	0.005	U

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-PZ02P-R01		OW01-PZ03-R01		OW01-PZ04-R01		OW01-PZ05-R01		OW1-MW10-R01	
Volatile Organic Compounds (UG/L)										
1,1,1,2-Tetrachloroethane	1	U	10	U	1	U	1	U	1	U
1,1,1-Trichloroethane	1	U	10	U	1	U	1	U	1	U
1,1,2,2-Tetrachloroethane	1	U	10	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	10	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	10	U	1	J	1	U	1	U
1,1-Dichloroethene	1	U	10	U	1	U	1	U	1	U
1,1-Dichloropropene	1	U	10	U	1	U	1	U	1	U
1,2,3-Trichlorobenzene	1	U	10	U	1	U	1	U	1	U
1,2,3-Trichloropropane	1	U	10	U	1	U	1	U	1	U
1,2,4-Trichlorobenzene	1	U	10	U	1	U	1	U	1	U
1,2,4-Trimethylbenzene	1	U	10	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	10	U	1	U	1	U	1	U
1,2-Dichlorobenzene	1	U	10	U	1	U	1	U	1	U
1,2-Dichloroethane	1	U	10	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	10	U	1	U	1	U	1	U
1,3,5-Trimethylbenzene	1	U	10	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	10	U	1	U	1	U	1	U
1,3-Dichloropropane	1	U	10	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	10	U	1	U	1	U	1	U
2,2-Dichloropropane	1	U	10	U	1	U	1	U	1	U
Benzene	1		6	J	2		1	U	1	U
Bromobenzene	1	U	10	U	1	U	1	U	1	U
Bromochloromethane	1	U	10	U	1	U	1	U	1	U
Bromodichloromethane	1	U	10	U	1	U	1	U	1	U
Bromoform	1	U	10	U	1	U	1	U	1	U
Bromomethane	1	U	10	U	1	U	1	U	1	U
Carbon tetrachloride	1	U	10	U	1	U	1	U	1	U
Chlorobenzene	1	U	10	U	1	U	1	U	1	U
Chloroethane	1	U	10	U	1	U	1	U	1	U
Chloroform	1	U	9	B	1	U	1	U	1	U
Chloromethane	1	U	10	U	1	U	1	U	1	U
Cumene	4		10	U	1		1	J	1	U
Dibromochloromethane	1	U	10	U	1	U	1	U	1	U

Chemical Name	OW01-PZ02P-R01		OW01-PZ03-R01		OW01-PZ04-R01		OW01-PZ05-R01		OW1-MW10-R01	
Dibromomethane	1	U	10	U	1	U	1	U	1	U
Dichlorodifluoromethane	1	U	10	U	1	U	1	U	1	U
Ethylbenzene	1	U	17		6		4		1	U
Hexachlorobutadiene	1	U	10	U	1	U	1	U	1	U
Methylene chloride	1	B	7	B	1	U	1	U	1	B
Styrene	1	U	10	U	1	U	1	U	1	U
Tetrachloroethene	1	U	10	U	1	U	1	U	1	U
Toluene	1	U	35		9		1	J	1	U
Trichloroethene	1	U	10	U	1	U	1	U	1	J
Trichlorofluoromethane	1	U	10	U	1	U	1	U	1	U
Vinyl chloride	1	U	10	U	1	U	1	U	1	U
Xylene, total	1	J	66		12		7		1	U
cis-1,2-Dichloroethene	1	U	10	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	10	U	1	U	1	U	1	U
n-Butylbenzene	1	U	10	U	1	U	1	U	1	U
n-Propylbenzene	5		10	U	2		1	U	1	U
o-Chlorotoluene	1	U	10	U	1	U	1	U	1	U
o-Xylene	1	U	11		4		1	J	1	U
p-Chlorotoluene	1	U	10	U	1	U	1	U	1	U
p-Isopropyltoluene	1	U	10	U	2		1		1	U
sec-Butylbenzene	5		10	U	1	U	1	U	1	U
tert-Butylbenzene	1	U	10	U	1	U	1	U	1	U
trans-1,2-Dichloroethene	1	U	10	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	10	U	1	U	1	U	1	U
Semivolatile Organic Compounds (UG/L)										
Acenaphthene	0.096	J	9.2	B	3.1	B	0.24	B	0.22	U
Acenaphthylene	1	U	11	U	5.3	U	1	U	1.1	U
Anthracene	0.35	B	1.6	B	0.62	B	0.16	B	0.11	U
Benzo(a)anthracene	0.01	U	0.11	U	0.053	U	0.01	U	0.011	U
Benzo(a)pyrene	0.1	U	1.1	U	0.53	U	0.1	U	0.11	U
Benzo(b)fluoranthene	0.41	U	4.2	U	2.1	U	0.41	U	0.45	U
Benzo(g,h,i)perylene	0.2	U	2.1	U	1.1	U	0.2	U	0.22	U
Benzo(k)fluoranthene	0.82	U	8.4	U	4.3	U	0.82	U	0.9	U
Chrysene	0.01	U	0.11	U	0.053	U	0.01	U	0.011	U
Dibenz(a,h)anthracene	0.2	U	2.1	U	1.1	U	0.2	U	0.22	U

Table A-1-1
Analytical Results - Groundwater - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-PZ02P-R01		OW01-PZ03-R01		OW01-PZ04-R01		OW01-PZ05-R01		OW1-MW10-R01	
Fluoranthene	2.3		85	B	31	B	8.6	B	1.1	U
Fluorene	0.41	U	45	B	17	B	0.66	B	0.45	U
Indeno(1,2,3-cd)pyrene	0.41	U	4.2	U	2.1	U	0.41	U	0.45	U
Naphthalene	22		10	U	22		13		1	U
Phenanthrene	0.051	U	2.5	B	0.98	B	0.052	B	0.021	B
Pyrene	0.005	U	0.053	U	0.027	U	0.002	J	0.006	U

Table A-1-2
Analytical Results - Surface Water - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SW05P		OW01-SW05		OW01-SW06		OW01-SW07		OW01-SW08	
Volatile Organic Compounds (UG/L)										
1,1,1-Trichloroethane	1	U	1	U	1	U	1	U	1	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	1	U	1	U	1	U	1	U	1	U
1,2-Dichloroethane	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U	1	U	1	U
2-Hexanone	5	U	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone	5	U	5	U	5	U	5	U	5	U
Benzene	1	U	1	U	1	U	1	U	1	U
Bromochloromethane	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	0.2	J	0.2	J	0.2	J	1	U	1	U
Bromoform	1	U	1	U	1	U	1	U	1	U
Bromomethane	1	U	1	U	1	U	1	U	1	U
Carbon disulfide	1.3	B	0.3	B	0.4	B	0.4	B	0.4	B
Carbon tetrachloride	1	U	1	U	1	U	1	U	1	U
Chlorobenzene	1	U	1	U	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U	1	U	1	U
Chloroform	1.2	B	1.1	B	1	B	0.8	B	0.7	B
Chloromethane	1	U	1	U	1	U	1	U	1	U
Dibromochloromethane	1	U	1	U	1	U	1	U	1	U
Ethylbenzene	1	U	1	U	1	U	1	U	1	U
Methylene chloride	1.1	B	1.2	B	1.1	B	0.9	B	1	B
Styrene	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	1	U	1	U	1	U	1	U	1	U
Toluene	1	U	1	U	1	U	1	U	1	U
Trichloroethene	1	U	1	U	1	U	1	U	1	U
Vinyl chloride	1	U	1	U	1	U	1	U	1	U
Xylene, total	1	U	1	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U

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Chemical Name	OW01-SW05P		OW01-SW05		OW01-SW06		OW01-SW07		OW01-SW08	
trans-1,2-Dichloroethene	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	1	U	1	U	1	U	1	U	1	U
Semivolatile Organic Compounds (UG/L)										
1,2,4-Trichlorobenzene	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U
2,2'-Oxybis(1-chloropropane)	11	U	11	U	11	U	12	U	11	U
2,4,5-Trichlorophenol	28	U	28	U	27	U	30	U	28	U
2,4,6-Trichlorophenol	11	U	11	U	11	U	12	U	11	U
2,4-Dichlorophenol	11	U	11	U	11	U	12	U	11	U
2,4-Dimethylphenol	11	U	11	U	11	U	12	U	11	U
2,4-Dinitrophenol	28	U	28	U	27	U	30	U	28	U
2,4-Dinitrotoluene	11	U	11	U	11	U	12	U	11	U
2,6-Dinitrotoluene	11	U	11	U	11	U	12	U	11	U
2-Chloronaphthalene	11	U	11	U	11	U	12	U	11	U
2-Chlorophenol	11	U	11	U	11	U	12	U	11	U
2-Methylnaphthalene	11	U	11	U	11	U	12	U	11	U
2-Methylphenol	11	U	11	U	11	U	12	U	11	U
2-Nitroaniline	28	U	28	U	27	U	30	U	28	U
2-Nitrophenol	11	U	11	U	11	U	12	U	11	U
3,3'-Dichlorobenzidine	11	U	11	U	11	U	12	U	11	U
3-Nitroaniline	28	U	28	U	27	U	30	U	28	U
4,6-Dinitro-2-methylphenol	28	U	28	U	27	U	30	U	28	U
4-Bromophenyl-phenylether	11	U	11	U	11	U	12	U	11	U
4-Chloro-3-methylphenol	11	U	11	U	11	U	12	U	11	U
4-Chloroaniline	11	U	11	U	11	U	12	U	11	U
4-Chlorophenyl-phenylether	11	U	11	U	11	U	12	U	11	U
4-Methylphenol	11	U	11	U	11	U	12	U	11	U
4-Nitroaniline	28	U	28	U	27	U	30	U	28	U
4-Nitrophenol	28	U	28	U	27	U	30	U	28	U
Acenaphthene	0.23	U	0.232	U	0.22	U	0.238	U	0.228	U
Acenaphthylene	1.15	U	1.16	U	1.1	U	1.19	U	1.14	U
Anthracene	0.564		0.275	B	0.11	U	0.252	B	0.214	B
Benzo(a)anthracene	0.012	J	0.011	J	0.015	J	0.019	J	0.015	J

Table A-1-2
Analytical Results - Surface Water - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SW05P		OW01-SW05		OW01-SW06		OW01-SW07		OW01-SW08	
Benzo(a)pyrene	0.115	U	0.116	U	0.11	U	0.119	U	0.114	U
Benzo(b)fluoranthene	0.876		0.447	J	0.675		0.485		0.665	
Benzo(g,h,i)perylene	0.23	U	0.232	U	0.22	U	0.238	U	0.228	U
Benzo(k)fluoranthene	0.92	U	0.928	U	0.88	U	0.952	U	0.912	U
Butylbenzylphthalate	11	U	11	U	11	U	12	U	11	U
Carbazole	11	U	11	U	11	U	12	U	11	U
Chrysene	0.021	J	0.017	J	0.031	J	0.04	J	0.042	J
Di-n-butylphthalate	11	U	11	U	11	U	1	B	11	U
Di-n-octyl phthalate	11	UJ	11	UJ	11	UJ	12	UJ	11	UJ
Dibenz(a,h)anthracene	0.23	U	0.232	U	0.22	U	0.238	U	0.228	U
Dibenzofuran	11	U	11	U	11	U	12	U	11	U
Diethylphthalate	11	U	11	U	11	U	12	U	11	U
Dimethyl phthalate	11	U	11	U	11	U	12	U	11	U
Fluoranthene	3.85	B	1.71	B	1.1	U	4.15	B	3.47	B
Fluorene	0.46	U	0.464	U	0.44	U	0.476	U	0.456	U
Hexachlorobenzene	11	U	11	U	11	U	12	U	11	U
Hexachlorobutadiene	11	U	11	U	11	U	12	U	11	U
Hexachlorocyclopentadiene	11	U	11	U	11	U	12	U	11	U
Hexachloroethane	11	U	11	U	11	U	12	U	11	U
Indeno(1,2,3-cd)pyrene	0.46	U	0.464	U	0.44	U	0.476	U	0.456	U
Isophorone	11	U	11	U	11	U	12	U	11	U
Naphthalene	2.3	U	2.32	U	2.2	U	2.38	U	2.28	U
Nitrobenzene	11	U	11	U	11	U	12	U	11	U
Pentachlorophenol	28	U	28	U	27	U	30	U	28	U
Phenanthrene	0.052	J	0.032	J	0.032	J	0.033	J	0.031	J
Phenol	11	U	11	U	11	U	12	U	11	U
Pyrene	0.006		0.005	J	0.007		0.008		0.008	
bis(2-Chloroethoxy)methane	11	U	11	U	11	U	12	U	11	U
bis(2-Chloroethyl)ether	11	U	11	U	11	U	12	U	11	U
bis(2-Ethylhexyl)phthalate	11	U	11	U	11	U	12	U	11	U
n-Nitroso-di-n-propylamine	11	U	11	U	11	U	12	U	11	U
n-Nitrosodiphenylamine	11	U	11	U	11	U	12	U	11	U
Pesticides/PCBs (UG/L)										
4,4'-DDD	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U
4,4'-DDE	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U

Table A-1-2
Analytical Results - Surface Water - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SW05P		OW01-SW05		OW01-SW06		OW01-SW07		OW01-SW08	
4,4'-DDT	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U
Aldrin	0.055	U	0.057	U	0.054	UJ	0.057	U	0.056	U
Aroclor-1016	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Aroclor-1221	2.2	U	2.3	U	2.2	U	2.3	U	2.2	U
Aroclor-1232	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Aroclor-1242	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Aroclor-1248	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Aroclor-1254	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Aroclor-1260	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Dieldrin	0.11	U	0.11	U	0.11	UJ	0.11	U	0.11	U
Endosulfan I	0.055	U	0.057	U	0.054	U	0.057	U	0.056	U
Endosulfan II	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U
Endosulfan sulfate	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U
Endrin	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U
Endrin aldehyde	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U
Endrin ketone	0.11	U	0.11	U	0.11	U	0.11	U	0.11	U
Heptachlor	0.055	U	0.057	U	0.054	UJ	0.057	U	0.056	U
Heptachlor epoxide	0.055	U	0.057	U	0.054	U	0.057	U	0.056	U
Methoxychlor	0.55	UJ	0.57	UJ	0.54	UJ	0.57	UJ	0.56	UJ
Toxaphene	5.5	U	5.7	U	5.4	U	5.7	U	5.6	U
alpha-BHC	0.055	U	0.057	U	0.054	U	0.057	U	0.056	U
alpha-Chlordane	0.055	U	0.057	U	0.054	U	0.057	U	0.056	U
beta-BHC	0.055	U	0.057	U	0.054	U	0.057	U	0.056	U
delta-BHC	0.055	U	0.057	U	0.054	U	0.057	U	0.056	U
gamma-BHC (Lindane)	0.055	U	0.057	U	0.054	UJ	0.057	U	0.056	U
gamma-Chlordane	0.055	U	0.057	U	0.054	U	0.057	U	0.056	U
Metals (UG/L)										
Aluminum	548		557		493		371		577	
Antimony	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U
Arsenic	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U
Barium	26	J	27.4	J	26.5	J	27.1	J	28.1	J
Beryllium	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Cadmium	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U
Calcium	6070		6510		6290		6640		6720	
Chromium	0.95	J	1.2	J	0.83	J	0.72	J	1.2	J

Table A-1-2
Analytical Results - Surface Water - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SW05P		OW01-SW05		OW01-SW06		OW01-SW07		OW01-SW08	
Cobalt	2.1	B	1.9	B	2	B	1.5	B	2	B
Copper	2.3	B	2.9	B	3.9	B	4.4	B	2.6	B
Cyanide	5	U	5	U	5	U	5	U	5	U
Iron	1290		1320		1330		1260		1260	
Lead	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
Magnesium	4040	J	4320	J	4130	J	4210	J	4320	J
Manganese	61.5		65.3		62.4		63.9		63.3	
Mercury	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Nickel	2.5	B	3.3	B	2.6	B	2.1	B	2.4	B
Potassium	907	B	1040	B	896	B	898	B	979	B
Selenium	2.7	UL	2.7	UL	2.7	UL	2.7	UL	3.9	B
Silver	0.7	U	0.7	U	0.7	U	0.7	U	0.7	U
Sodium	8150	J	8660	J	8430	J	8450	J	8620	J
Thallium	3.8	U	3.8	U	3.8	U	3.8	U	3.8	U
Vanadium	1.6	J	1.4	J	1.3	J	1.2	J	1.4	J
Zinc	14.5	B	16.9	B	16.5	B	15.7	B	17.3	B

Table A-1-3
Analytical Results - Sediment - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SD09P		OW01-SD09		OW01-SD10		OW01-SD11		OW01-SD12	
Volatile Organic Compounds (UG/KG)										
1,1,1-Trichloroethane	2	J	2	J	2	J	1	J	14	UL
1,1,2,2-Tetrachloroethane	12	U	12	U	14	U	13	U	14	UL
1,1,2-Trichloroethane	2	J	2	J	2	J	2	J	2	L
1,1-Dichloroethane	2	J	2	J	2	J	2	J	1	L
1,1-Dichloroethene	2	J	12	U	14	U	1	J	14	UL
1,2-Dichloroethane	2	J	1	J	14	U	13	U	14	UL
1,2-Dichloroethene (total)	4	J	3	J	3	J	3	J	3	L
1,2-Dichloropropane	2	J	2	J	1	J	13	U	14	UL
2-Butanone	12	UJ	12	UJ	14	UJ	13	UJ	14	UJ
2-Hexanone	12	UJ	12	UJ	14	UJ	13	UJ	14	UJ
4-Methyl-2-pentanone	12	U	12	U	14	U	13	U	14	UL
Acetone	12	UJ	12	UJ	12	J	15	J	24	J
Benzene	2	B	2	B	2	B	2	B	14	UL
Bromodichloromethane	1	J	12	U	14	U	13	U	14	UL
Bromoform	12	U	12	U	14	U	13	U	14	UL
Bromomethane	2	J	1	J	14	U	1	J	14	UL
Carbon disulfide	12	U	12	U	3	J	3	J	4	L
Carbon tetrachloride	2	J	1	J	14	U	13	U	14	UL
Chlorobenzene	2	J	2	J	2	J	2	J	2	L
Chloroethane	2	J	2	J	14	U	1	J	14	UL
Chloroform	5	B	5	B	5	B	5	B	5	B
Chloromethane	2	J	1	J	1	J	2	J	14	UL
Dibromochloromethane	12	U	12	U	14	U	13	U	14	UL
Ethylbenzene	2	B	2	B	2	B	2	B	14	UL
Methylene chloride	22	B	12	B	14	B	14	B	14	B
Styrene	12	U	12	U	14	U	13	U	14	UL
Tetrachloroethene	3	B	3	B	3	B	3	B	3	B
Toluene	2	B	2	B	2	B	2	B	2	B
Trichloroethene	2	J	2	J	2	J	2	J	14	UL
Vinyl chloride	2	J	1	J	14	U	1	J	14	UL
Xylene, total	6	B	5	B	5	B	5	B	14	UL
cis-1,3-Dichloropropene	12	U	12	U	14	U	13	U	14	UL
trans-1,3-Dichloropropene	12	U	12	U	14	U	13	U	14	UL

Table A-1-3
Analytical Results - Sediment - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SD09P		OW01-SD09		OW01-SD10		OW01-SD11		OW01-SD12	
Semivolatile Organic Compounds (UG/KG)										
1,2,4-Trichlorobenzene	NS		410	UL	460	UJ	440	UL	470	UL
1,2-Dichlorobenzene	NS		410	UL	460	UL	440	UL	470	UL
1,3-Dichlorobenzene	NS		410	UL	460	UL	440	UL	470	UL
1,4-Dichlorobenzene	NS		410	UL	460	UJ	440	UL	470	UL
2,2'-Oxybis(1-chloropropane)	NS		410	UL	460	UL	440	UL	470	UL
2,4,5-Trichlorophenol	1000	U	1000	UL	1200	U	1100	UL	1200	U
2,4,6-Trichlorophenol	410	U	410	UL	460	U	440	UL	470	U
2,4-Dichlorophenol	410	U	410	U	460	U	440	UL	470	U
2,4-Dimethylphenol	410	U	410	U	460	U	440	UL	470	U
2,4-Dinitrophenol	1000	U	1000	U	1200	U	1100	UL	1200	U
2,4-Dinitrotoluene	NS		410	UL	460	UL	440	UL	470	UL
2,6-Dinitrotoluene	NS		410	UL	460	UL	440	UL	470	UL
2-Chloronaphthalene	NS		410	UL	460	UL	440	UL	470	UL
2-Chlorophenol	410	U	410	U	460	U	440	UL	470	U
2-Methylnaphthalene	NS		410	UL	460	UL	440	UL	470	UL
2-Methylphenol	410	U	410	U	460	U	440	UL	470	U
2-Nitroaniline	NS		1000	UL	1200	UL	1100	UL	1200	UL
2-Nitrophenol	410	U	410	U	460	U	440	UL	470	U
3,3'-Dichlorobenzidine	NS		410	UL	460	UL	440	UL	470	UL
3-Nitroaniline	NS		1000	UL	1200	UL	1100	UL	1200	UL
4,6-Dinitro-2-methylphenol	1000	U	1000	U	1200	U	1100	UL	1200	U
4-Bromophenyl-phenylether	NS		410	UL	460	UL	440	UL	470	UL
4-Chloro-3-methylphenol	410	U	410	U	460	U	440	UL	470	U
4-Chloroaniline	NS		410	UL	460	UL	440	UL	470	UL
4-Chlorophenyl-phenylether	NS		410	UL	460	UL	440	UL	470	UL
4-Methylphenol	410	U	410	U	460	U	440	UL	470	U
4-Nitroaniline	NS		1000	UL	1200	UL	1100	UL	1200	UL
4-Nitrophenol	1000	U	1000	U	1200	U	1100	UL	1200	U
Acenaphthene	162	U	162	U	183	U	176	U	186	U
Acenaphthylene	811	U	410	UL	460	UL	440	UL	470	UL
Anthracene	81.1	U	81	U	91.7	U	88	U	93.2	U
Benzo(a)anthracene	6.1	J	8.1	UJ	6.86	J	47	L	12.4	J
Benzo(a)pyrene	81.1	U	81	U	91.7	U	88	U	93.2	U
Benzo(b)fluoranthene	2970		592		1770		1310		2610	

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Table A-1-3
Analytical Results - Sediment - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SD09P		OW01-SD09		OW01-SD10		OW01-SD11		OW01-SD12	
Benzo(g,h,i)perylene	162	U	162	U	183	U	240	L	186	U
Benzo(k)fluoranthene	639	U	410	UL	460	UL	440	UL	470	UL
Butylbenzylphthalate	NS		410	UL	460	UL	440	UL	470	UL
Carbazole	NS		410	UL	460	UL	440	UL	470	UL
Chrysene	17.7	J	7.7	J	14.2	J	57	L	24.5	J
Di-n-butylphthalate	NS		410	UL	460	UL	440	UL	470	UL
Di-n-octylphthalate	NS		410	UL	460	UL	440	UL	470	UL
Dibenz(a,h)anthracene	162	UJ	162	UJ	183	UJ	176	UJ	186	UJ
Dibenzofuran	NS		410	UL	460	UL	440	UL	470	UL
Diethylphthalate	47	L	45	L	110	L	80	L	120	L
Dimethyl phthalate	NS		410	UL	460	UL	440	UL	470	UL
Fluoranthene	811	U	410	UL	460	UL	440	UL	705	J
Fluorene	319	U	319	U	361	U	347	U	367	U
Hexachlorobenzene	NS		410	UL	460	UL	440	UL	470	UL
Hexachlorobutadiene	NS		410	UL	460	UL	440	UL	470	UL
Hexachlorocyclopentadiene	NS		410	UL	460	UL	440	UL	470	UL
Hexachloroethane	NS		410	UL	460	UL	440	UL	470	UL
Indeno(1,2,3-cd)pyrene	319	U	319	U	361	U	347	U	367	U
Isophorone	NS		410	UL	460	UL	440	UL	470	UL
Naphthalene	1620	U	410	UL	460	UL	59	L	470	UL
Nitrobenzene	NS		410	UL	460	UL	440	UL	470	UL
Pentachlorophenol	1000	U	1000	U	1200	U	1100	UL	1200	U
Phenanthrene	41.8	UJ	41.7	UJ	47.2	UJ	45.3	UJ	48	UJ
Phenol	410	U	410	U	460	U	440	UL	470	U
Pyrene	1.98	J	4.17	U	3.74	J	92	L	4.86	
bis(2-Chloroethoxy)methane	NS		410	UL	460	UL	440	UL	470	UL
bis(2-Chloroethyl)ether	NS		410	UL	460	UL	440	UL	470	UL
bis(2-Ethylhexyl)phthalate	NS		410	UL	460	UL	440	UL	470	UL
n-Nitroso-di-n-propylamine	NS		410	UL	460	UL	440	UL	470	UL
n-Nitrosodiphenylamine	NS		410	UL	460	UL	440	UL	470	UL
Pesticides/PCBs (UG/KG)										
4,4'-DDD	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
4,4'-DDE	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
4,4'-DDT	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
Aldrin	2	U	2	U	2.3	U	2.2	U	2.3	U

Table A-1-3
Analytical Results - Sediment - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SD09P		OW01-SD09		OW01-SD10		OW01-SD11		OW01-SD12	
Aroclor-1016	41	U	41	U	46	U	44	U	47	U
Aroclor-1221	82	U	81	U	92	U	88	U	94	U
Aroclor-1232	41	U	41	U	46	U	44	U	47	U
Aroclor-1242	41	U	41	U	46	U	44	U	47	U
Aroclor-1248	41	U	41	U	46	U	44	U	47	U
Aroclor-1254	41	U	41	U	46	U	44	U	47	U
Aroclor-1260	41	U	41	U	46	U	44	U	47	U
Dieldrin	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
Endosulfan I	2	U	2	U	2.3	U	2.2	U	2.3	U
Endosulfan II	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
Endosulfan sulfate	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
Endrin	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
Endrin aldehyde	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
Endrin ketone	4.1	U	4.1	U	4.6	U	4.4	U	4.7	U
Heptachlor	2	U	2	U	2.3	U	2.2	U	2.3	U
Heptachlor epoxide	2	U	2	U	2.3	U	2.2	U	2.3	U
Methoxychlor	20	U	20	U	23	U	22	U	23	U
Toxaphene	200	U	200	U	230	U	220	U	230	U
alpha-BHC	2	U	2	U	2.3	U	2.2	U	2.3	U
alpha-Chlordane	2	U	2	U	2.3	U	2.2	U	2.3	U
beta-BHC	2	U	2	U	2.3	U	2.2	U	2.3	U
delta-BHC	2	U	2	U	2.3	U	2.2	U	2.3	U
gamma-BHC (Lindane)	2	U	2	U	2.3	UJ	2.2	U	2.3	U
gamma-Chlordane	2	U	2	U	2.3	U	2.2	U	2.3	U
Metals (MG/KG)										
Aluminum	439		373		754		639		631	
Antimony	0.38	U	0.47	U	0.56	U	0.53	U	0.4	U
Arsenic	0.47	U	0.57	U	0.69	U	2.2	J	5.3	
Barium	2.9	J	2.6	J	6.4	J	6.9	J	7.4	J
Beryllium	0.04	J	0.04	J	0.08	J	0.19	J	0.23	J
Cadmium	0.1	B	0.09	B	0.13	B	0.17	B	0.13	B
Calcium	75.1	B	66.8	B	186	J	169	J	147	B
Chromium	1.2	J	1	J	2	J	1.6	J	1.5	J
Cobalt	0.33	B	0.26	B	0.57	B	1.1	B	1.4	B
Copper	0.82	B	0.87	B	1.4	B	1.4	B	1.8	J

Table A-1-3
Analytical Results - Sediment - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	OW01-SD09P		OW01-SD09		OW01-SD10		OW01-SD11		OW01-SD12	
Cyanide	0.22	U	0.22	U	0.29	U	0.26	U	0.25	U
Iron	463		693		878		2960		5520	
Lead	0.85		0.79		1.5		1.4		1.7	
Magnesium	57.7	B	46.4	B	99.8	J	72.7	J	65.4	J
Manganese	2.9		2.2	J	4.3		11.9		19	
Mercury	0.02	U	0.01	U	0.02	U	0.02	U	0.02	U
Nickel	0.6	B	0.47	B	1	B	1.4	B	1.5	B
Potassium	53	B	46.7	B	70	B	58.9	B	44.6	B
Selenium	0.47	U	0.57	U	0.71	J	0.65	U	0.49	U
Silver	0.12	U	0.15	U	0.18	U	0.17	U	0.13	U
Sodium	28.3	U	34.4	U	41.4	U	39.4	U	29.4	U
Thallium	0.66	U	0.8	U	0.97	U	0.92	U	0.69	U
Vanadium	1.2	J	1.2	J	1.9	J	2.7	J	2.5	J
Zinc	5.4	B	3.5	B	7.5	B	11.8	B	12.2	B

Table A-1-4
Analytical Results - Surface Soil - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	1-SS1		1-SS2		1-SS3		1-SS4		1-SS5		1-SS6		1-SS7		1-SS8		1-SS8 FD		OW01-SS09	
	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
1,1,1-Trichloroethane																			0.014	UL
1,1,2,2-Tetrachloroethane																			0.014	UL
1,1,2-Trichloroethane																			0.002	L
1,1-Dichloroethane																			0.014	UL
1,1-Dichloroethene																			0.014	UL
1,2,4-Trichlorobenzene																			0.47	U
1,2-Dichlorobenzene																			0.47	U
1,2-Dichloroethane																			0.014	UL
1,2-Dichloroethene (total)																			0.002	L
1,2-Dichloropropane																			0.014	UL
1,3-Dichlorobenzene																			0.47	U
1,4-Dichlorobenzene																			0.47	U
1-Methylnapthalene	0.063	U	0.058	U	0.056	U	0.066		0.06	U	0.06	U	0.057	U	0.055	U	0.056	U		
2,2'-Oxybis(1-chloropropane)																			0.47	U
2,4,5-Trichlorophenol																			1.2	U
2,4,6-Trichlorophenol																			0.47	U
2,4-Dichlorophenol																			0.47	U
2,4-Dimethylphenol																			0.47	U
2,4-Dinitrophenol																			1.2	U
2,4-Dinitrotoluene																			0.47	U
2,6-Dinitrotoluene																			0.47	U
2-Butanone	0.072		0.012	U															0.014	UJ
2-Chloronaphthalene																			0.47	U
2-Chlorophenol																			0.47	U
2-Hexanone																			0.014	UJ
2-Methylnaphthalene	0.063	U	0.058	U	0.056	U	0.21		0.06	U	0.06	U	0.057	U	0.055	U	0.056	U	0.47	U
2-Methylphenol																			0.47	U
2-Nitroaniline																			1.2	U
2-Nitrophenol																			0.47	U
3,3'-Dichlorobenzidine																			0.47	U
3-Nitroaniline																			1.2	U
4,4'-DDD																			0.0047	U
4,4'-DDE																			0.00073	J
4,4'-DDT																			0.0047	U

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Table A-1-4
Analytical Results - Surface Soil - SWMU 1
NAS Oceana, Virginia Beach,VA

Chemical Name	1-SS1	1-SS2	1-SS3	1-SS4	1-SS5	1-SS6	1-SS7	1-SS8	1-SS8 FD	OW01-SS09
	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
4,6-Dinitro-2-methylphenol										1.2 U
4-Bromophenyl-phenylether										0.47 U
4-Chloro-3-methylphenol										0.47 U
4-Chloroaniline										0.47 U
4-Chlorophenyl-phenylether										0.47 U
4-Methyl-2-pentanone										0.014 UL
4-Methylphenol										0.47 U
4-Nitroaniline										1.2 U
4-Nitrophenol										1.2 U
Acenaphthene	0.063 U	0.058 U	0.056 U	0.06 U	0.06 U	0.06 U	0.086	0.055 U	0.056 U	0.186 U
Acenaphthylene										0.47 U
Acetone	0.02	0.008 J								0.014 UJ
Aldrin										0.0023 U
alpha-BHC										0.0023 U
alpha-Chlordane										0.0015 J
Aluminum	15700	14900								5430
Anthracene										0.0928 U
Antimony	4.2 UN	5.9 BN								0.39 U
Aroclor-1016										0.047 U
Aroclor-1221										0.093 U
Aroclor-1232										0.047 U
Aroclor-1242										0.047 U
Aroclor-1248										0.047 U
Aroclor-1254	0.14	0.02 U								0.047 U
Aroclor-1260	0.022 U	0.02 U								0.047 U
Arsenic	3	3.5								0.79 J
Barium	67.2	78.8								27.3 J
Benzene	0.006 U	0.006 U	0.0012 U	0.0012 U	0.0012 U	0.0013 U	0.0012 U	0.0012 U	0.0012 U	0.014 UL
Benzo (a) anthracene	0.063 U	0.19	0.22	0.18	0.079 U	0.063 U	0.12	0.072	0.072	
Benzo (a) pyrene	0.063 U	0.23	0.2	0.1	0.079	0.06 U	0.091	0.057 U	0.064	
Benzo (b) fluoranthene	0.063 U	0.2	0.16	0.06 U	0.17	0.06 U	0.057 U	0.055 U	0.056 U	
Benzo (g,h,i) perylene	0.063 U	0.13	0.12	0.06 U	0.12 U	0.072 U	0.072	0.055 U	0.056 U	
Benzo (k) fluoranthene	0.063 U	0.22	0.15	0.06 U	0.06 U	0.06 U	0.057 U	0.055 U	0.056 U	
Benzo(a)anthracene										0.00771 J

Table A-1-4
Analytical Results - Surface Soil - SWMU 1
NAS Oceana, Virginia Beach, VA

Chemical Name	1-SS1	1-SS2	1-SS3	1-SS4	1-SS5	1-SS6	1-SS7	1-SS8	1-SS8 FD	OW01-SS09
	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Benzo(a)pyrene										0.0928 U
Benzo(b)fluoranthene										0.366 U
Benzo(g,h,i)perylene										0.186 U
Benzo(k)fluoranthene										0.47 U
Beryllium	0.49 B	0.54 B								0.18 J
beta-BHC										0.0023 U
bis(2-Chloroethoxy)methane										0.47 U
bis(2-Chloroethyl)ether										0.47 U
bis(2-Ethylhexyl)phthalate										0.47 U
Bromodichloromethane										0.014 UL
Bromoform										0.014 UL
Bromomethane										0.014 UL
Butylbenzylphthalate										0.47 U
Cadmium	0.7 U	1.3								0.42 J
Calcium	1080	1040 B								385 J
Carbazole										0.47 U
Carbon Disulfide	0.008	0.004 J								0.014 UL
Carbon tetrachloride										0.014 UL
Chlorobenzene										0.014 UL
Chloroethane										0.014 UL
Chloroform										0.004 B
Chloromethane										0.014 UL
Chromium	18.9	20.6								8.5
Chrysene	0.063 U	0.29	0.21	0.16	0.06 U	0.06 U	0.091	0.055 U	0.056 U	0.0142 J
cis-1,3-Dichloropropene										0.014 UL
Cobalt	3.1 B	3.9 B								1.2 B
Copper	13.1	12								5.2 B
Cyanide										0.29 U
delta-BHC										0.0023 U
Di-n-Butylphthalate										0.47 U
Di-n-octyl phthalate										0.47 U
Dibenz(a,h)anthracene										0.186 UJ
Dibenzo (a, h) anthracene	0.063 U	0.058 U	0.056 U	0.06 U	0.06 U	0.06 U	0.057 U	0.055 U	0.056 U	
Dibenzofuran										0.47 U

Table A-1-4
Analytical Results - Surface Soil - SWMU 1
NAS Oceana, Virginia Beach,VA

Chemical Name	1-SS1	1-SS2	1-SS3	1-SS4	1-SS5	1-SS6	1-SS7	1-SS8	1-SS8 FD	OW01-SS09
	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Dibromochloromethane										0.014 UL
Dieldrin										0.0047 U
Diethylphthalate										0.048 J
Dimethyl phthalate										0.47 U
Endosulfan I										0.0023 U
Endosulfan II										0.0047 U
Endosulfan sulfate										0.0047 U
Endrin										0.0047 U
Endrin aldehyde										0.0047 U
Endrin ketone										0.0047 U
Ethylbenzene	0.001 J	0.006 U	0.0012 U	0.0012 U	0.0012 U	0.0013 U	0.0012 U	0.0012 U	0.0012 U	0.014 UL
Fluoranthene	0.063 U	0.47	0.34	0.12	0.06 U	0.06 U	0.15	0.068	0.067	0.47 U
Fluorene	0.063 U	0.035 J	0.056 U	0.06 U	0.06 U	0.06 U	0.057 U	0.055 U	0.056 U	0.366 U
gamma-BHC (Lindane)										0.0023 U
gamma-Chlordane										0.0023 U
Heptachlor										0.0023 U
Heptachlor epoxide										0.0023 U
Hexachlorobenzene										0.47 U
Hexachlorobutadiene										0.47 U
Hexachlorocyclopentadiene										0.47 U
Hexachloroethane										0.47 U
Indeno (1,2,3-cd) pyrene	0.063 U	0.17	0.15	0.11	0.06 U	0.1 U	0.13	0.055 U	0.056 U	
Indeno(1,2,3-cd)pyrene										0.366 U
Iron	6140	17300								2980
Isophorone										0.47 U
Lead	45.5	32.7								17.8
Magnesium	961 B	876 B								425 J
Manganese	27.5	36.7								12.9
Mercury	0.09 B	0.23								0.04 J
Methoxychlor										0.023 U
Methylene Chloride	0.028 B	0.017 B								0.013 B
n-Nitroso-di-n-propylamine										0.47 U
n-Nitrosodiphenylamine										0.47 U
Naphthalene	0.063 U	0.058 U	0.056 U	0.13	0.06 U	0.06 U	0.057 U	0.055 U	0.056 U	0.47 U

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Table A-1-4
Analytical Results - Surface Soil - SWMU 1
NAS Oceana, Virginia Beach,VA

Chemical Name	1-SS1	1-SS2	1-SS3	1-SS4	1-SS5	1-SS6	1-SS7	1-SS8	1-SS8 FD	OW01-SS09
	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Nickel	9.5 B	8.4 B								5.1 B
Nitrobenzene										0.47 U
Pentachlorophenol										1.2 U
Phenanthrene	0.063 U	0.26	0.12	0.11	0.06 U	0.06 U	0.075	0.055 U	0.056 U	0.0478 UJ
Phenol										0.47 U
Potassium	666 B	587 B								246 B
Pyrene	0.063 U	0.37	0.29	0.12	0.06 U	0.06 U	0.12	0.08	0.073	0.00443 J
Selenium	0.65 B	0.87 B								0.82 J
Silver	0.51 U	0.48 U								0.12 U
Sodium	251 B	262 B								28.9 U
Styrene	0.006 U	0.006 U								0.014 UL
Tetrachloroethene										0.002 B
Thallium	0.59 U	0.56 U								0.68 U
Toluene	0.025	0.006 U	0.0012 U	0.0012 U	0.0012 U	0.0013 U	0.0012 U	0.0012 U	0.0012 U	0.002 B
Total Petroleum Hydrocarbons			2	280	68.8	16.4	26.7	19.6	23.4	
Toxaphene										0.23 U
Trichloroethene										0.014 UL
Vanadium	20	19.7								10.4
Vinyl chloride										0.014 UL
Xylene (Total)	0.015	0.005 J	0.0024 U	0.0025 U	0.0025 U	0.0026 U	0.0025 U	0.0025 U	0.0024 U	0.014 UL
Zinc	52.9	85.1								21.9 B

Table A-2-1
Analytical Results - Groundwater - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-MW06-R01		OW15-MW07-R01		OW15-MW08-R01		OW15-MW13-R02		OW15-MW18-R01		OW15-MW19-R01		OW15-MW20-R01		OW15-MW22-R01		OW15-MW21-R01	
Volatile Organic Compounds (UG/L)																		
1,1,1-Trichloroethane	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
1,1,2,2-Tetrachloroethane	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane	10	U	200	U	10	U	2	U	1	U	1	U	3.8		1	U	1	U
1,1-Dichloroethene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	10	U	200	U	10	U	NS		1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloroethane	10	U	200	U	10	U	3	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	10	U	200	U	10	U	NS		1	U	1	U	1	U	1	U	1	U
2-Hexanone	50	U	1,000	U	50	U	NS		5	U	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone	50	U	1,000	U	50	U	NS		5	U	5	U	5	U	5	U	5	U
Benzene	135.7		3,444		180.1		2	U	1	U	70	J	115.8	L	1	U	1	U
Bromochloromethane	10	U	200	U	10	U	NS		1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Bromoform	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Bromomethane	10	U	200	U	10	U	2	U	1	UJ	1	UJ	1	U	1	U	1	U
Carbon disulfide	10	U	194	J	21.7	J	NS		1.1	B	1	B	5	B	2.5	B	1.4	B
Carbon tetrachloride	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Chlorobenzene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Chloroethane	10	UJ	200	UJ	10	UJ	2	U	1	UJ	1	UJ	1	UJ	1	UJ	1	UJ
Chloroform	10	U	278		12.5		2	U	1	U	1	U	1	U	1	U	1	U
Chloromethane	10	UJ	200	UJ	10	UJ	2	U	1	UJ	1	UJ	1	UJ	1	UJ	1	UJ
Dibromochloromethane	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Dichlorodifluoromethane	NS		NS		NS		2	U	NS		NS		NS		NS		NS	
Ethane	NS		NS		NS		0.015		NS		NS		NS		NS		NS	
Ethene	NS		NS		NS		0.005	U	NS		NS		NS		NS		NS	
Ethylbenzene	10	U	200	U	10	U	2	U	1	U	244.1	J	5.1		1	U	1	U
Methane	1,200	L	3,200	L	540	L	2.503		530	L	480	L	800	L	20		23	
Methylene chloride	54.3	B	216	J	10.8	B	2	U	1.1	B	1.9	B	0.9	B	0.5	B	0.5	B
Styrene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	5.1	J	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Toluene	2.2	J	200	U	10	U	3	U	1	U	3.6		1.8		1	U	1	U
Trichloroethene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Vinyl chloride	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Xylene, total	10	U	200	U	10	U	NS		1	U	882.2	J	72.8	L	1	U	1	U
m- and p-Xylene	NS		NS		NS		2	U	NS		NS		NS		NS		NS	
o-Xylene	NS		NS		NS		2	U	NS		NS		NS		NS		NS	
cis-1,2-Dichloroethene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
trans-1,2-Dichloroethene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene	10	U	200	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U
Semivolatile Organic Compounds (UG/L)																		
1,2,4-Trichlorobenzene	10	U	11	U	10	U	2	U	1	U	1	U	1	U	1	U	1	U

Table A-2-1
Analytical Results - Groundwater - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-MW06-R01	OW15-MW07-R01	OW15-MW08-RO1	OW15-MW13-R02	OW15-MW18-R01	OW15-MW19-R01	OW15-MW20-R01	OW15-MW22-R01	OW15-MW21-R01
1,2-Dichlorobenzene	10 U	11 U	10 U	2 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	10 U	11 U	10 U	2 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	10 U	11 U	10 U	2 U	1 U	1 U	1 U	1 U	1 U
2,2'-Oxybis(1-chloropropane)	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2,4,5-Trichlorophenol	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
2,4,6-Trichlorophenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2,4-Dichlorophenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2,4-Dimethylphenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2,4-Dinitrophenol	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
2,4-Dinitrotoluene	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2,6-Dinitrotoluene	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2-Chloronaphthalene	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2-Chlorophenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2-Methylnaphthalene	12 U	11 U	12 U	NS	11 U	4 J	11 U	11 U	11 U
2-Methylphenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
2-Nitroaniline	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
2-Nitrophenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
3,3'-Dichlorobenzidine	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
3-Nitroaniline	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
4,6-Dinitro-2-methylphenol	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
4-Bromophenyl-phenylether	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
4-Chloro-3-methylphenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
4-Chloroaniline	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
4-Chlorophenyl-phenylether	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
4-Methylphenol	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
4-Nitroaniline	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
4-Nitrophenol	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
Acenaphthene	0.2 U	0.222 U	12 U	NS	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U
Acenaphthylene	1 U	1.11 U	12 U	NS	1 UJ	1 U	1 U	1 U	1 U
Anthracene	0.165	0.25	12 U	NS	0.392 J	0.283 J	0.452 J	0.551 J	0.409 J
Benzo(a)anthracene	0.007 J	0.01 J	12 U	NS	0.01 UJ	0.01 U	0.007 J	0.05	0.01 U
Benzo(a)pyrene	0.1 U	0.111 U	12 U	NS	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U
Benzo(b)fluoranthene	0.4 U	0.444 U	12 U	NS	0.4 UJ	0.4 U	0.4 U	0.4 U	0.4 U
Benzo(g,h,i)perylene	0.2 U	0.222 U	12 U	NS	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U
Benzo(k)fluoranthene	0.8 U	0.888 U	12 U	NS	0.8 UJ	0.8 U	0.8 U	0.8 U	0.8 U
Butylbenzylphthalate	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Carbazole	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Chrysene	0.023	0.025	12 U	NS	0.015 J	0.01 U	0.015	0.061	0.01 U
Di-n-butylphthalate	12 U	1 J	12 U	NS	1 J	1 J	11 U	11 U	11 U
Di-n-octyl phthalate	12 UJ	11 UJ	12 U	NS	11 U	11 U	11 U	11 U	11 U
Dibenz(a,h)anthracene	0.2 U	0.222 U	12 U	NS	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U
Dibenzofuran	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Diethylphthalate	3 J	2 J	12 U	NS	11 U	11 U	11 U	11 U	11 U
Dimethyl phthalate	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U

Table A-2-1
Analytical Results - Groundwater - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-MW06-R01	OW15-MW07-R01	OW15-MW08-RO1	OW15-MW13-R02	OW15-MW18-R01	OW15-MW19-R01	OW15-MW20-R01	OW15-MW22-R01	OW15-MW21-R01
Fluoranthene	1 U	3.278	12 U	NS	4.25 J	4.49	6.02	6.54	4.03
Fluorene	0.4 U	0.444 U	12 U	NS	0.4 UJ	0.4 U	0.4 U	0.386 J	0.4 U
Hexachlorobenzene	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Hexachlorobutadiene	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Hexachlorocyclopentadiene	12 UJ	11 UJ	12 U	NS	11 U	11 U	11 U	11 U	11 U
Hexachloroethane	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Indeno(1,2,3-cd)pyrene	0.4 U	0.444 U	12 U	NS	0.4 UJ	0.4 U	0.4 U	0.4 U	0.4 U
Isophorone	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Naphthalene	3 J	28	12 U	NS	2 UJ	13	2 U	2 U	2 U
Nitrobenzene	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Pentachlorophenol	29 U	28 U	29 U	NS	28 U	28 U	28 U	27 U	29 U
Phenanthrene	0.027 J	0.037 J	12 U	NS	0.077 J	0.18 J	0.078 J	0.329 J	0.041 J
Phenol	3 J	34 J	6 J	NS	11 U	11 U	2 J	11 U	11 U
Pyrene	0.005 U	0.003 J	12 U	NS	0.004 J	0.005 U	0.004 J	0.011	0.005
bis(2-Chloroethoxy)methane	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
bis(2-Chloroethyl)ether	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
bis(2-Ethylhexyl)phthalate	12 U	11 U	12 U	NS	1 J	1 J	11 U	11 U	11 U
n-Nitroso-di-n-propylamine	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
n-Nitrosodiphenylamine	12 U	11 U	12 U	NS	11 U	11 U	11 U	11 U	11 U
Pesticide/PCBs (UG/L)									
4,4'-DDD	0.1 U	0.1 U	0.1 U	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
4,4'-DDE	0.1 U	0.1 U	0.1 U	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
4,4'-DDT	0.1 U	0.1 U	0.1 U	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Aldrin	0.05 U	0.05 U	0.05 U	NS	0.057 U	0.057 U	0.054 U	0.057 U	0.054 U
Aroclor-1016	1 U	1 U	1 U	NS	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Aroclor-1221	2 U	2 U	2 U	NS	2.3 U	2.3 U	2.2 U	2.3 U	2.2 U
Aroclor-1232	1 U	1 U	1 U	NS	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Aroclor-1242	1 U	1 U	1 U	NS	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Aroclor-1248	1 U	1 U	1 U	NS	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Aroclor-1254	1 U	1 U	1 U	NS	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Aroclor-1260	1 U	1 U	1 U	NS	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Dieldrin	0.1 U	0.1 U	0.1 UJ	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Endosulfan I	0.05 U	0.05 U	0.05 U	NS	0.057 U	0.057 U	0.054 U	0.057 U	0.054 U
Endosulfan II	0.1 U	0.1 U	0.1 U	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Endosulfan sulfate	0.1 U	0.1 U	0.1 U	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Endrin	0.1 U	0.1 U	0.1 UJ	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Endrin aldehyde	0.1 U	0.1 U	0.1 U	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Endrin ketone	0.1 U	0.1 U	0.1 U	NS	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	NS	0.057 U	0.057 U	0.054 U	0.057 U	0.054 U
Heptachlor epoxide	0.05 U	0.05 U	0.05 U	NS	0.057 U	0.057 U	0.054 U	0.057 U	0.054 U
Methoxychlor	0.5 U	0.5 U	0.5 U	NS	0.57 UJ	0.57 UJ	0.54 UJ	0.57 UJ	0.54 UJ
Toxaphene	5 U	5 U	5 U	NS	5.7 U	5.7 U	5.4 U	5.7 U	5.4 U
alpha-BHC	0.05 U	0.05 U	0.05 U	NS	0.057 U	0.057 U	0.054 U	0.057 U	0.054 U
alpha-Chlordane	0.05 U	0.05 U	0.05 U	NS	0.057 U	0.057 U	0.054 U	0.057 U	0.054 U

Chemical Name	OW15-MW06-R01		OW15-MW07-R01		OW15-MW08-RO1		OW15-MW13-R02		OW15-MW18-R01		OW15-MW19-R01		OW15-MW20-R01		OW15-MW22-R01		OW15-MW21-R01	
beta-BHC	0.05	U	0.05	U	0.05	U	NS		0.057	UJ	0.057	UJ	0.054	UJ	0.057	UJ	0.054	UJ
delta-BHC	0.05	U	0.05	U	0.05	U	NS		0.057	U	0.057	U	0.054	U	0.057	U	0.054	U
gamma-BHC (Lindane)	0.05	U	0.05	U	0.05	UJ	NS		0.057	U	0.057	U	0.054	U	0.057	U	0.054	U
gamma-Chlordane	0.05	U	0.05	U	0.05	U	NS		0.057	U	0.057	U	0.054	U	0.057	U	0.054	U
Total Metals (UG/L)																		
Aluminum	177	B	256	B	440		NS		585		126	B	94	B	130	B	72.8	B
Antimony	2.2	U	2.2	U	2.2	U	NS		2.2	U	2.2	U	2.2	U	2.2	U	2.2	U
Arsenic	8.6	J	2.7	U	2.7	U	NS		7.3	B	5.9	B	5.3	B	19.6		18	
Barium	17.7	J	49.6	J	25.5	J	NS		44.5	J	49.2	J	62.3	J	50	J	44.7	J
Beryllium	0.1	U	0.1	U	0.25	J	NS		0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Cadmium	0.3	U	0.3	U	0.3	U	NS		0.3	U	0.3	U	0.3	U	0.3	U	0.3	U
Calcium	8,090		12,400		4,160	J	NS		4,060	J	4,960	J	7,660		7,570		7,520	
Chromium	1.7	B	1.7	J	1.3	B	NS		1.6	J	1	J	0.6	U	0.8	J	0.66	J
Cobalt	0.5	U	0.6	J	1.9	J	NS		7.1	J	1.4	J	2.9	J	9.9	J	9.6	J
Copper	13.7	J	7.9	B	6.3	B	NS		4.1	B	3.4	B	3.6	B	4.3	B	3.4	B
Cyanide	5	U	5	U	5	U	NS		5	U	5	U	5	U	5	U	5	U
Iron	2,320		3,490		557		NS		2,170		13,900		13,500		15,400		15,200	
Ferric iron	NS		NS		NS		500	U	NS		NS		NS		NS		NS	
Ferrous iron	NS		NS		NS		500	U	NS		NS		NS		NS		NS	
Lead	2.9	J	1.6	U	1.6	U	NS		1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
Magnesium	9,520		14,500		3,360	J	NS		7,870		14,700		19,900		20,600		20,700	
Manganese	40.4		41.7		24.2		500	U	131		241		260		490		490	
Mercury	0.1	U	0.1	U	0.1	U	NS		0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Nickel	1.9	B	2.3	B	3.5	B	NS		9.7	J	4.3	B	5.5	B	10.3	J	9.9	J
Potassium	110	B	472	J	347	J	NS		1,200	J	982	J	1,000	J	843	J	832	J
Selenium	2.7	U	2.7	U	2.7	U	NS		2.7	U	2.7	U	2.7	U	2.7	U	2.7	U
Silver	0.7	U	0.7	U	0.7	U	NS		0.78	B	0.7	U	0.7	U	1	B	0.7	U
Sodium	15,800		21,800		9,770		NS		15,800		13,500		27,000		12,800		12,600	
Sulfate	17,700		1,000	U	18,600		NS		15,700		37,800		86,500		129,000		128,000	
Thallium	3.8	U	3.8	U	3.8	U	NS		3.8	U	3.8	U	3.8	U	3.8	U	3.8	U
Vanadium	2.4	J	2.9	J	0.87	J	NS		2.5	J	1.3	J	1.4	J	1.5	J	0.87	J
Zinc	112		48.2		33.8		NS		12.8	J	7.2	B	8.4	B	12.6	J	11.1	B

Table A-2-2
Analytical Results - Surface Water - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SW01P		OW15-SW01		OW15-SW02		OW15-SW03		OW15-SW04		OW15-SW05	
Volatile Organic Compounds (UG/L)												
1,1,1-Trichloroethane	1	U	1	U	1	U	NS		NS		NS	
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	NS		NS		NS	
1,1,2-Trichloroethane	1	U	1	U	1	U	NS		NS		NS	
1,1-Dichloroethane	1	U	1	U	1	U	NS		NS		NS	
1,1-Dichloroethene	1	U	1	U	1	U	NS		NS		NS	
1,2-Dibromo-3-chloropropane	1	U	1	U	1	U	NS		NS		NS	
1,2-Dibromoethane	1	U	1	U	1	U	NS		NS		NS	
1,2-Dichloroethane	1	U	1	U	1	U	NS		NS		NS	
1,2-Dichloropropane	1	U	1	U	1	U	NS		NS		NS	
2-Hexanone	5	U	5	U	5	U	NS		NS		NS	
4-Methyl-2-pentanone	5	U	5	U	5	U	NS		NS		NS	
Acetone	6.4	L	6.9	L	7.2	L	NS		NS		NS	
Benzene	1	U	1	U	1	U	NS		NS		NS	
Bromochloromethane	1	U	1	U	1	U	NS		NS		NS	
Bromodichloromethane	1	U	1	U	1	U	NS		NS		NS	
Bromoform	1	U	1	U	1	U	NS		NS		NS	
Bromomethane	1	U	1	U	1	U	NS		NS		NS	
Carbon disulfide	0.5	B	0.2	B	0.3	B	NS		NS		NS	
Carbon tetrachloride	1	U	1	U	1	U	NS		NS		NS	
Chlorobenzene	1	U	1	U	1	U	NS		NS		NS	
Chloroethane	1	U	1	U	1	U	NS		NS		NS	
Chloroform	1	U	1	U	1	U	NS		NS		NS	
Chloromethane	1	U	1	U	1	U	NS		NS		NS	
Dibromochloromethane	1	U	1	U	1	U	NS		NS		NS	
Ethylbenzene	1	U	1	U	1	U	NS		NS		NS	
Methylene chloride	1.2	B	1.1	B	1.2	B	NS		NS		NS	
Styrene	1	U	1	U	1	U	NS		NS		NS	
Tetrachloroethene	1	U	1	U	1	U	NS		NS		NS	
Toluene	1	U	1	U	1	U	NS		NS		NS	
Trichloroethene	1	U	1	U	1	U	NS		NS		NS	
Vinyl chloride	1	U	1	U	1	U	NS		NS		NS	
Xylene, total	1	U	1	U	1	U	NS		NS		NS	
cis-1,2-Dichloroethene	1	U	1	U	1	U	NS		NS		NS	
cis-1,3-Dichloropropene	1	U	1	U	1	U	NS		NS		NS	

Chemical Name	OW15-SW01P		OW15-SW01		OW15-SW02		OW15-SW03		OW15-SW04		OW15-SW05	
trans-1,2-Dichloroethene	1	U	1	U	1	U	NS		NS		NS	
trans-1,3-Dichloropropene	1	U	1	U	1	U	NS		NS		NS	
Semivolatile Organic Compounds (UG/L)												
1,2,4-Trichlorobenzene	1	U	1	U	1	U	10	U	10	U	10	U
1,2-Dichlorobenzene	1	U	1	U	1	U	10	U	10	U	10	U
1,3-Dichlorobenzene	1	U	1	U	1	U	10	U	10	U	10	U
1,4-Dichlorobenzene	1	U	1	U	1	U	10	U	10	U	10	U
2,2'-Oxybis(1-chloropropane)	10	U	10	U	10	U	10	U	10	U	10	U
2,4,5-Trichlorophenol	26	U	26	U	26	U	26	U	26	U	26	U
2,4,6-Trichlorophenol	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dichlorophenol	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dimethylphenol	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dinitrophenol	26	U	26	U	26	U	26	U	26	U	26	U
2,4-Dinitrotoluene	10	U	10	U	10	U	10	U	10	U	10	U
2,6-Dinitrotoluene	10	U	10	U	10	U	10	U	10	U	10	U
2-Chloronaphthalene	10	U	10	U	10	U	10	U	10	U	10	U
2-Chlorophenol	10	U	10	U	10	U	10	U	10	U	10	U
2-Methylnaphthalene	10	U	10	U	10	U	10	U	10	U	10	U
2-Methylphenol	10	U	10	U	10	U	10	U	10	U	10	U
2-Nitroaniline	26	U	26	U	26	U	26	U	26	U	26	U
2-Nitrophenol	10	U	10	U	10	U	10	U	10	U	10	U
3,3'-Dichlorobenzidine	10	U	10	U	10	U	10	U	10	U	10	U
3-Nitroaniline	26	U	26	U	26	U	26	U	26	U	26	U
4,6-Dinitro-2-methylphenol	26	U	26	U	26	U	26	U	26	U	26	U
4-Bromophenyl-phenylether	10	U	10	U	10	U	10	U	10	U	10	U
4-Chloro-3-methylphenol	10	U	10	U	10	U	10	U	10	U	10	U
4-Chloroaniline	10	U	10	U	10	U	10	U	10	U	10	U
4-Chlorophenyl-phenylether	10	U	10	U	10	U	10	U	10	U	10	U
4-Methylphenol	10	U	10	U	10	U	10	U	10	U	10	U
4-Nitroaniline	26	U	26	U	26	U	26	U	26	U	26	U
4-Nitrophenol	26	U	26	U	26	U	26	U	26	U	26	U
Acenaphthene	0.2	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U
Acenaphthylene	1	U	1	U	1	U	1	U	1	UJ	1	U
Anthracene	0.1	U	0.411	J	0.665	J	0.1	U	0.132	J	0.198	J
Benzo(a)anthracene	0.01	U	0.01	U	0.01	U	0.01	UJ	0.012	J	0.01	U

Table A-2-2
Analytical Results - Surface Water - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SW01P		OW15-SW01		OW15-SW02		OW15-SW03		OW15-SW04		OW15-SW05	
Benzo(a)pyrene	0.1	U	0.1	U	0.1	U	0.1	U	0.1	UJ	0.1	U
Benzo(b)fluoranthene	0.4	U	0.4	U	0.4	U	0.4	U	0.4	UJ	0.4	U
Benzo(g,h,i)perylene	0.2	U	0.2	U	0.2	U	0.2	UJ	1.86	J	0.2	U
Benzo(k)fluoranthene	0.8	U	0.8	U	0.8	U	0.8	U	0.8	UJ	0.8	U
Butylbenzylphthalate	10	U	10	U	10	U	10	U	10	U	10	U
Carbazole	10	U	10	U	10	U	10	U	10	U	10	U
Chrysene	0.01	U	0.01	U	0.01	U	0.005	J	0.039	J	0.041	J
Di-n-butylphthalate	10	U	3	B	1	B	3	B	10	U	10	U
Di-n-octyl phthalate	10	U	10	U	10	U	10	U	10	U	10	U
Dibenz(a,h)anthracene	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	UJ	0.2	U
Dibenzofuran	10	U	10	U	10	U	10	U	10	U	10	U
Diethylphthalate	10	U	10	U	10	U	10	U	10	U	10	U
Dimethyl phthalate	10	U	10	U	10	U	10	U	10	U	10	U
Fluoranthene	1	U	2.99		4.06	J	1	U	1.82	J	2.89	
Fluorene	0.4	U	0.4	U	0.4	U	0.4	U	0.4	UJ	0.4	U
Hexachlorobenzene	10	U	10	U	10	U	10	U	10	U	10	U
Hexachlorobutadiene	10	U	10	U	10	U	10	U	10	U	10	U
Hexachlorocyclopentadiene	10	U	10	U	10	U	10	U	10	U	10	U
Hexachloroethane	10	U	10	U	10	U	10	U	10	U	10	U
Indeno(1,2,3-cd)pyrene	0.4	U	0.4	U	0.4	U	0.4	U	0.095	J	0.4	U
Isophorone	10	U	10	U	10	U	10	U	10	U	10	U
Naphthalene	2	U	2	U	2	U	2	U	2	UJ	2	U
Nitrobenzene	10	U	10	U	10	U	10	U	10	U	10	U
Pentachlorophenol	26	U	26	U	26	U	26	U	26	U	26	U
Phenanthrene	0.05	U	0.029	J	0.033	J	0.05	UJ	0.026	J	0.049	J
Phenol	10	U	10	U	10	U	10	U	10	U	10	U
Pyrene	0.005	U	0.005	U	0.005	U	0.005	U	0.013	J	0.005	U
bis(2-Chloroethoxy)methane	10	U	10	U	10	U	10	U	10	U	10	U
bis(2-Chloroethyl)ether	10	U	10	U	10	U	10	U	10	U	10	U
bis(2-Ethylhexyl)phthalate	10	U	2	J	10	U	2	J	1	J	10	U
n-Nitroso-di-n-propylamine	10	U	10	U	10	U	10	U	10	U	10	U
n-Nitrosodiphenylamine	10	U	10	U	10	U	10	U	10	U	10	U
Pesticide/PCBs (UG/L)												
4,4'-DDD	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	
4,4'-DDE	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	

Table A-2-2
Analytical Results - Surface Water - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SW01P		OW15-SW01		OW15-SW02		OW15-SW03		OW15-SW04		OW15-SW05	
4,4'-DDT	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	
Aldrin	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
Aroclor-1016	1	U	1	UJ	1.1	U	NS		NS		NS	
Aroclor-1221	2.1	U	2	UJ	2.1	U	NS		NS		NS	
Aroclor-1232	1	U	1	UJ	1.1	U	NS		NS		NS	
Aroclor-1242	1	U	1	UJ	1.1	U	NS		NS		NS	
Aroclor-1248	1	U	1	UJ	1.1	U	NS		NS		NS	
Aroclor-1254	1	U	1	UJ	1.1	U	NS		NS		NS	
Aroclor-1260	1	U	1	UJ	1.1	U	NS		NS		NS	
Dieldrin	0.1	UJ	0.1	UJ	0.11	U	NS		NS		NS	
Endosulfan I	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
Endosulfan II	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	
Endosulfan sulfate	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	
Endrin	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	
Endrin aldehyde	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	
Endrin ketone	0.1	U	0.1	UJ	0.11	U	NS		NS		NS	
Heptachlor	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
Heptachlor epoxide	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
Methoxychlor	0.52	U	0.51	UJ	0.53	U	NS		NS		NS	
Toxaphene	5.2	U	5.1	UJ	5.3	U	NS		NS		NS	
alpha-BHC	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
alpha-Chlordane	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
beta-BHC	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
delta-BHC	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
gamma-BHC (Lindane)	0.052	UJ	0.051	UJ	0.053	U	NS		NS		NS	
gamma-Chlordane	0.052	U	0.051	UJ	0.053	U	NS		NS		NS	
Total Metals (UG/L)												
Aluminum	113	J	114	J	120	J	113	J	191	J	104	J
Antimony	2.8	B	2.7	U	2.7	U	2.7	U	2.7	U	2.7	U
Arsenic	2	U	2	U	2	U	2	U	2	U	2	U
Barium	84.6	J	84.9	J	89.7	J	85.2	J	92.3	J	84	J
Beryllium	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Cadmium	0.3	U	0.3	U	0.3	U	0.4	J	0.3	U	0.3	U
Calcium	61,700		61,900		65,300		62,200		67,400		61,500	
Chromium	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U

Table A-2-2
Analytical Results - Surface Water - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SW01P		OW15-SW01		OW15-SW02		OW15-SW03		OW15-SW04		OW15-SW05	
Cobalt	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Copper	1.8	B	3	B	2.9	B	2	B	2.9	B	2.8	B
Cyanide	5	U	5	U	5	U	5.6		5	U	5	U
Iron	30.8	U	124		30.8	U	30.8	U	33.4	J	30.8	U
Lead	1	U	1	U	1	U	1	U	1	J	1	U
Magnesium	21,900		21,900		23,200		22,100		23,900		21,700	
Manganese	10.7	J	11.3	J	10.6	J	10.7	J	12.2	J	12.3	J
Mercury	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Nickel	0.9	U	0.9	U	0.9	U	0.9	U	0.9	U	0.9	U
Potassium	3,800	J	3,870	J	4,190	J	4,000	J	4,310	J	3,970	J
Selenium	2.6	U	2.6	U	2.6	U	2.6	U	2.6	U	2.6	U
Silver	0.9	U	0.9	U	0.9	U	0.9	U	0.9	U	0.9	U
Sodium	10,500		10,500		11,300		10,600		11,400		10,300	
Thallium	3.2	U	3.2	U	3.2	U	3.2	U	3.2	U	3.2	U
Vanadium	0.6	U	0.76	J	0.6	U	0.6	U	0.64	J	0.6	U
Zinc	6.5	B	12.1	B	17.7	B	9.5	B	11.6	B	13.3	B

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD01-7.0		OW15-SD02-7.0		OW15-SD03-2.5		OW15-SD04-5.5		OW15-SD05-2.5		OW15-SD06-5.5		OW15-SD07-7.0P		OW15-SD07-7.0		OW15-SD08-5.5	
Volatile Organic Compounds (UG/KG)																		
1,1,1-Trichloroethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,1,2,2-Tetrachloroethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,1,2-Trichloroethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,1-Dichloroethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,1-Dichloroethene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,2-Dichloroethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,2-Dichloroethene (total)	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,2-Dichloropropane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
2-Butanone	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
2-Hexanone	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
4-Methyl-2-pentanone	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Acetone	13	U	13	U	15	U	12	U	14	UJ	13	UJ	NS		NS		NS	
Benzene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Bromodichloromethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Bromoform	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Bromomethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Carbon disulfide	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Carbon tetrachloride	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Chlorobenzene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Chloroethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Chloroform	2	B	2	B	2	B	12	U	14	U	13	UJ	NS		NS		NS	
Chloromethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Dibromochloromethane	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Ethylbenzene	26	J	13	U	61		12	U	14	U	13	UJ	NS		NS		NS	
Methylene chloride	13	U	13	U	16	B	12	U	23	B	13	UJ	NS		NS		NS	
Styrene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Tetrachloroethene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Toluene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Trichloroethene	13	U	13	U	15	U	12	UJ	14	U	13	UJ	NS		NS		NS	
Vinyl chloride	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
Xylene, total	13	U	13	U	94		12	U	14	U	13	UJ	NS		NS		NS	
cis-1,3-Dichloropropene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
trans-1,3-Dichloropropene	13	U	13	U	15	U	12	U	14	U	13	UJ	NS		NS		NS	
1,1,1,2-Tetrachloroethane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,1-Dichloropropene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,2,3-Trichlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,2,3-Trichloropropane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,2,4-Trichlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,2,4-Trimethylbenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,2-Dibromo-3-chloropropane	NS		NS		NS		NS		NS		NS		NS		NS		NS	

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD01-7.0		OW15-SD02-7.0		OW15-SD03-2.5		OW15-SD04-5.5		OW15-SD05-2.5		OW15-SD06-5.5		OW15-SD07-7.0P		OW15-SD07-7.0		OW15-SD08-5.5	
1,2-Dibromoethane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,2-Dichlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,3,5-Trimethylbenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,3-Dichlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,3-Dichloropropane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,4-Dichlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
2,2-Dichloropropane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Bromobenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Bromochloromethane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Cumene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Dibromomethane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Dichlorodifluoromethane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Hexachlorobutadiene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Naphthalene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Trichlorofluoromethane	NS		NS		NS		NS		NS		NS		NS		NS		NS	
cis-1,2-Dichloroethene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
n-Butylbenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
n-Propylbenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
o-Chlorotoluene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
o-Xylene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
p-Chlorotoluene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
p-Isopropyltoluene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
sec-Butylbenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
tert-Butylbenzene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
trans-1,2-Dichloroethene	NS		NS		NS		NS		NS		NS		NS		NS		NS	
Thallium	NS		NS		NS		NS		NS		NS		NS		NS		0.87	U
Semivolatile Organic Compounds (UG/KG)																		
1,2,4-Trichlorobenzene	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
1,2-Dichlorobenzene	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
1,3-Dichlorobenzene	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
1,4-Dichlorobenzene	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
2,2'-Oxybis(1-chloropropane)	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
2,4,5-Trichlorophenol	1,100	UJ	1,100	UJ	1,200	UJ	1,000	U	1,200	UJ	1,100	UJ	1,100	U	1,500	UJ	1,100	U
2,4,6-Trichlorophenol	430	UJ	440	UJ	490	UJ	410	U	470	UJ	420	UJ	430	U	580	UJ	460	U
2,4-Dichlorophenol	430	UJ	440	UJ	490	UJ	410	U	470	UJ	420	UJ	430	U	580	UJ	460	U
2,4-Dimethylphenol	430	UJ	440	UJ	490	UJ	410	U	470	UJ	420	UJ	430	U	580	UJ	460	U
2,4-Dinitrophenol	1,100	UJ	1,100	UJ	1,200	UJ	1,000	U	1,200	UJ	1,100	UJ	1,100	U	1,500	UJ	1,100	U
2,4-Dinitrotoluene	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
2,6-Dinitrotoluene	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
2-Chloronaphthalene	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
2-Chlorophenol	430	UJ	440	UJ	490	UJ	410	U	470	UJ	420	UJ	430	U	580	UJ	460	U

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD01-7.0	OW15-SD02-7.0	OW15-SD03-2.5	OW15-SD04-5.5	OW15-SD05-2.5	OW15-SD06-5.5	OW15-SD07-7.0P	OW15-SD07-7.0	OW15-SD08-5.5
2-Methylnaphthalene	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	250 L	250 J	460 UL
2-Methylphenol	430 UJ	440 UJ	490 UJ	410 U	470 UJ	420 UJ	430 U	580 UJ	460 U
2-Nitroaniline	1,100 UJ	1,100 UJ	1,200 UJ	NS	1,200 UJ	1,100 UJ	NS	1,500 UJ	1,100 UL
2-Nitrophenol	430 UJ	440 UJ	490 UJ	410 U	470 UJ	420 UJ	430 U	580 UJ	460 U
3,3'-Dichlorobenzidine	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
3-Nitroaniline	1,100 UJ	1,100 UJ	1,200 UJ	NS	1,200 UJ	1,100 UJ	NS	1,500 UJ	1,100 UL
4,6-Dinitro-2-methylphenol	1,100 UJ	1,100 UJ	1,200 UJ	1,000 U	1,200 UJ	1,100 UJ	1,100 U	1,500 UJ	1,100 U
4-Bromophenyl-phenylether	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
4-Chloro-3-methylphenol	430 UJ	440 UJ	490 UJ	410 U	470 UJ	420 UJ	430 U	580 UJ	460 U
4-Chloroaniline	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
4-Chlorophenyl-phenylether	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
4-Methylphenol	430 UJ	440 UJ	490 UJ	410 U	470 UJ	420 UJ	430 U	580 UJ	460 U
4-Nitroaniline	1,100 UJ	1,100 UJ	1,200 UJ	NS	1,200 UJ	1,100 UJ	NS	1,500 UJ	1,100 UL
4-Nitrophenol	1,100 UJ	1,100 UJ	1,200 UJ	1,000 U	1,200 UJ	1,100 UJ	1,100 U	1,500 UJ	1,100 U
Acenaphthene	171.6 U	86.46 U	9.702 U	81.576 U	7.52 U	166.45 U	520.803 J	115.96 U	8.98 U
Acenaphthylene	430 UJ	432.3 U	48.5 U	407.88 U	37.62 U	420 UJ	4,220 U	579.81 U	44.9 U
Anthracene	85.8 UJ	43.23 UJ	4.851 UJ	40.788 UJ	3.76 UJ	83.226 UJ	422.004 UJ	57.981 UJ	8.08
Benzo(a)anthracene	5.495 J	4.323 U	1.118 J	4.079 U	0.575 J	15.855 J	108.787 J	5.355 J	1.1
Benzo(a)pyrene	85.8 U	43.23 U	4.851 U	40.788 U	3.76 U	83.226 U	422.004 U	57.981 U	4.49 U
Benzo(b)fluoranthene	338 U	170.3 U	19.1 U	145.853 J	14.82 U	327.86 U	1,662 U	228.41 U	17.7 U
Benzo(g,h,i)perylene	171.6 U	86.46 U	9.702 U	81.576 U	7.52 U	166.45 U	844.008 U	115.96 U	8.98 U
Benzo(k)fluoranthene	430 UJ	340.6 U	38.2 U	321.36 U	29.64 U	420 UJ	3,325 U	456.82 U	35.4 U
Butylbenzylphthalate	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Carbazole	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Chrysene	20.542 J	4.323 U	1.972 J	3.198 J	0.817 J	33.312 J	233.186 J	17.386 J	1.73
Di-n-butylphthalate	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	51 L
Di-n-octyl phthalate	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Dibenz(a,h)anthracene	171.6 U	86.46 U	9.702 U	81.576 U	7.52 U	166.45 U	844.008 U	115.96 U	8.98 U
Dibenzofuran	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Diethylphthalate	430 UJ	440 UJ	490 UJ	55 L	470 UJ	420 UJ	280 L	950 J	460 UL
Dimethyl phthalate	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Fluoranthene	430 UJ	2,010	48.5 U	407.88 U	37.62 U	832.26 U	4,220 U	579.81 U	44.9 U
Fluorene	338 U	170.3 U	19.1 U	160.68 U	14.82 U	327.86 U	1,662 U	228.41 U	17.7 U
Hexachlorobenzene	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Hexachlorobutadiene	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Hexachlorocyclopentadiene	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Hexachloroethane	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Indeno(1,2,3-cd)pyrene	338 U	170.3 U	19.1 U	160.68 U	14.82 U	327.86 U	1,662 U	228.41 U	17.7 U
Isophorone	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL
Naphthalene	430 UJ	440 UJ	97 U	815.76 U	75.24 U	420 UJ	98 L	75 J	89.8 U
Nitrobenzene	430 UJ	440 UJ	490 UJ	NS	470 UJ	420 UJ	NS	580 UJ	460 UL

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Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD01-7.0		OW15-SD02-7.0		OW15-SD03-2.5		OW15-SD04-5.5		OW15-SD05-2.5		OW15-SD06-5.5		OW15-SD07-7.0P		OW15-SD07-7.0		OW15-SD08-5.5	
Pentachlorophenol	1,100	UJ	1,100	UJ	1,200	UJ	1,000	U	1,200	UJ	1,100	UJ	1,100	U	1,500	UJ	1,100	U
Phenanthrene	44.2	U	22.27	U	1.41	J	21.012	U	1.94	U	42.874	U	217.396	U	29.869	U	2.01	J
Phenol	430	UJ	440	UJ	490	UJ	410	U	470	UJ	420	UJ	430	U	580	UJ	460	U
Pyrene	3.252	J	1.165	J	0.337		2.101	U	0.194	U	3.087	J	27.879		1.74	J	0.202	J
bis(2-Chloroethoxy)methane	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
bis(2-Chloroethyl)ether	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
bis(2-Ethylhexyl)phthalate	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
n-Nitroso-di-n-propylamine	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
n-Nitrosodiphenylamine	430	UJ	440	UJ	490	UJ	NS		470	UJ	420	UJ	NS		580	UJ	460	UL
Pesticide/PCBs (UG/KG)																		
4,4'-DDD	4.3	U	4.4	U	4.9	U	0.54	J	4.7	U	4.2	U	NS		NS		NS	
4,4'-DDE	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
4,4'-DDT	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
Aldrin	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
Aroclor-1016	43	U	44	U	49	U	41	U	47	U	42	U	NS		NS		NS	
Aroclor-1221	87	U	87	U	98	U	82	U	93	U	84	U	NS		NS		NS	
Aroclor-1232	43	U	44	U	49	U	41	U	47	U	42	U	NS		NS		NS	
Aroclor-1242	43	U	44	U	49	U	41	U	47	U	42	U	NS		NS		NS	
Aroclor-1248	43	U	44	U	49	U	41	U	47	U	42	U	NS		NS		NS	
Aroclor-1254	43	U	44	U	49	U	41	U	47	U	42	U	NS		NS		NS	
Aroclor-1260	43	U	44	U	49	U	41	U	47	U	42	U	NS		NS		NS	
Dieldrin	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
Endosulfan I	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
Endosulfan II	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
Endosulfan sulfate	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
Endrin	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
Endrin aldehyde	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
Endrin ketone	4.3	U	4.4	U	4.9	U	4.1	U	4.7	U	4.2	U	NS		NS		NS	
Heptachlor	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
Heptachlor epoxide	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
Methoxychlor	22	U	22	U	24	U	21	U	23	U	21	U	NS		NS		NS	
Toxaphene	220	U	220	U	240	U	210	U	230	U	210	U	NS		NS		NS	
alpha-BHC	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
alpha-Chlordane	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
beta-BHC	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
delta-BHC	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
gamma-BHC (Lindane)	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
gamma-Chlordane	2.2	U	2.2	U	2.4	U	2.1	U	2.3	U	2.1	U	NS		NS		NS	
Total Metals (MG/KG)																		
Aluminum	6,690		3,860		19,800		3,830		28,200		13,600		6,300		9,330		5,630	
Antimony	0.54	U	0.57	U	0.52	U	0.49	U	0.47	U	0.54	U	0.41	U	0.69	U	0.74	UL

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD01-7.0	OW15-SD02-7.0	OW15-SD03-2.5	OW15-SD04-5.5	OW15-SD05-2.5	OW15-SD06-5.5	OW15-SD07-7.0P	OW15-SD07-7.0	OW15-SD08-5.5
Arsenic	2.9	2.8	2.8	2.5	3.2	1.5 J	1.9	2.6 J	1.5 J
Barium	32.8 J	17.9 J	89.1	17.8 J	101	54.5	29.7 J	49.4 J	27.4 J
Beryllium	0.28 J	0.16 J	0.83 J	0.15 J	0.62 J	0.39 J	0.27 J	0.31 J	0.23 J
Cadmium	0.11 B	0.09 B	0.14 B	0.12 B	0.11 B	0.1 B	0.06 U	0.15 B	0.08 U
Calcium	456 B	232 B	468 B	285 B	676 B	1,200 J	1,040	3,210	399 J
Chromium	13.1	8.7	33.2	8.7	43.1	20.4	12.2	13.4	11.1
Cobalt	4.6 J	6.3 J	2.6 J	5.9 J	3.7 J	2.3 J	2.1 J	3.3 J	1.4 J
Copper	5.2 B	3.7 B	11.4	3.7 B	11.4	6.1 B	4.4 B	5.9 B	4.3 J
Cyanide	0.25 U	0.33	0.28 U	0.22 U	0.29 U	1.2	0.25 U	1.1	0.28 U
Iron	6,310	4,130	16,300	3,790	21,100	9,410	5,490	6,550	4,360
Lead	7.2 J	3.7 J	27.9 J	3 J	15 J	9.5 J	5.8 J	14.6 J	3.9
Magnesium	881 J	591 J	1,320	534 J	1,560	960 J	850 J	1,180 J	744 J
Manganese	29.6	22.2	23	19.5	27.9	26.2	27.9	74	21.5
Mercury	0.02 U	0.02 U	0.04	0.02 U	0.04 B	0.04	0.03 J	0.03 U	0.02 U
Nickel	7.6 J	7.9 J	9.6	7.3 J	12.3	6.6 J	5.1 J	6.5 J	3.9 J
Potassium	486 J	328 J	458 J	290 J	532 J	377 J	431 J	456 J	505 J
Selenium	0.66 U	0.72 B	0.81 B	0.6 U	1 B	0.83 B	0.51 U	0.85 U	0.71 U
Silver	0.17 U	0.18 U	0.17 U	0.15 U	0.15 U	0.17 U	0.13 U	0.22 U	0.25 U
Sodium	39.9 U	41.8 U	38.6 U	35.9 U	35 U	40.2 U	30.6 U	51 U	59.4 J
Vanadium	14	9 J	28.2	8.7 J	54.6	26.7	11.8	14.8 J	10.3 J
Zinc	22.1 J	15.9 J	20.7 J	16.1 J	28.8 J	15.3 J	16 J	17.9 J	13.2 J

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD09-2.5		OW15-SD10-5.5		OW15-SD11-2.5		OW15-SD12-5.5		OW15-SD13-7.0		OW15-SD14-7.0		OW15-SD15-7.0		OW15-SD16-0.0	
Volatile Organic Compounds (UG/KG)																
1,1,1-Trichloroethane	NS		NS		NS		NS		NS		NS		NS		NS	
1,1,2,2-Tetrachloroethane	NS		NS		NS		NS		NS		NS		NS		NS	
1,1,2-Trichloroethane	NS		NS		NS		NS		NS		NS		NS		NS	
1,1-Dichloroethane	NS		NS		NS		NS		NS		NS		NS		NS	
1,1-Dichloroethene	NS		NS		NS		NS		NS		NS		NS		NS	
1,2-Dichloroethane	NS		NS		NS		NS		NS		NS		NS		NS	
1,2-Dichloroethene (total)	NS		NS		NS		NS		NS		NS		NS		NS	
1,2-Dichloropropane	NS		NS		NS		NS		NS		NS		NS		NS	
2-Butanone	NS		NS		NS		NS		NS		NS		NS		NS	
2-Hexanone	NS		NS		NS		NS		NS		NS		NS		NS	
4-Methyl-2-pentanone	NS		NS		NS		NS		NS		NS		NS		NS	
Acetone	NS		NS		NS		NS		NS		NS		NS		NS	
Benzene	NS		NS		NS		NS		NS		NS		NS		NS	
Bromodichloromethane	NS		NS		NS		NS		NS		NS		NS		NS	
Bromoform	NS		NS		NS		NS		NS		NS		NS		NS	
Bromomethane	NS		NS		NS		NS		NS		NS		NS		NS	
Carbon disulfide	NS		NS		NS		NS		NS		NS		NS		NS	
Carbon tetrachloride	NS		NS		NS		NS		NS		NS		NS		NS	
Chlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS	
Chloroethane	NS		NS		NS		NS		NS		NS		NS		NS	
Chloroform	NS		NS		NS		NS		NS		NS		NS		NS	
Chloromethane	NS		NS		NS		NS		NS		NS		NS		NS	
Dibromochloromethane	NS		NS		NS		NS		NS		NS		NS		NS	
Ethylbenzene	NS		NS		NS		NS		NS		NS		NS		NS	
Methylene chloride	NS		NS		NS		NS		NS		NS		NS		NS	
Styrene	NS		NS		NS		NS		NS		NS		NS		NS	
Tetrachloroethene	NS		NS		NS		NS		NS		NS		NS		NS	
Toluene	NS		NS		NS		NS		NS		NS		NS		NS	
Trichloroethene	NS		NS		NS		NS		NS		NS		NS		NS	
Vinyl chloride	NS		NS		NS		NS		NS		NS		NS		NS	
Xylene, total	NS		NS		NS		NS		NS		NS		NS		NS	
cis-1,3-Dichloropropene	NS		NS		NS		NS		NS		NS		NS		NS	
trans-1,3-Dichloropropene	NS		NS		NS		NS		NS		NS		NS		NS	
1,1,1,2-Tetrachloroethane	NS		NS		NS		NS		NS		NS		NS		NS	
1,1-Dichloropropene	NS		NS		NS		NS		NS		NS		NS		NS	
1,2,3-Trichlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS	
1,2,3-Trichloropropane	NS		NS		NS		NS		NS		NS		NS		NS	
1,2,4-Trichlorobenzene	NS		NS		NS		NS		NS		NS		NS		NS	
1,2,4-Trimethylbenzene	NS		NS		NS		NS		NS		NS		NS		NS	
1,2-Dibromo-3-chloropropane	NS		NS		NS		NS		NS		NS		NS		NS	

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD09-2.5	OW15-SD10-5.5	OW15-SD11-2.5	OW15-SD12-5.5	OW15-SD13-7.0	OW15-SD14-7.0	OW15-SD15-7.0	OW15-SD16-0.0
1,2-Dibromoethane	NS	NS	NS	NS	NS	NS	NS	NS
1,2-Dichlorobenzene	NS	NS	NS	NS	NS	NS	NS	NS
1,3,5-Trimethylbenzene	NS	NS	NS	NS	NS	NS	NS	NS
1,3-Dichlorobenzene	NS	NS	NS	NS	NS	NS	NS	NS
1,3-Dichloropropane	NS	NS	NS	NS	NS	NS	NS	NS
1,4-Dichlorobenzene	NS	NS	NS	NS	NS	NS	NS	NS
2,2-Dichloropropane	NS	NS	NS	NS	NS	NS	NS	NS
Bromobenzene	NS	NS	NS	NS	NS	NS	NS	NS
Bromochloromethane	NS	NS	NS	NS	NS	NS	NS	NS
Cumene	NS	NS	NS	NS	NS	NS	NS	NS
Dibromomethane	NS	NS	NS	NS	NS	NS	NS	NS
Dichlorodifluoromethane	NS	NS	NS	NS	NS	NS	NS	NS
Hexachlorobutadiene	NS	NS	NS	NS	NS	NS	NS	NS
Naphthalene	NS	NS	NS	NS	NS	NS	NS	NS
Trichlorofluoromethane	NS	NS	NS	NS	NS	NS	NS	NS
cis-1,2-Dichloroethene	NS	NS	NS	NS	NS	NS	NS	NS
n-Butylbenzene	NS	NS	NS	NS	NS	NS	NS	NS
n-Propylbenzene	NS	NS	NS	NS	NS	NS	NS	NS
o-Chlorotoluene	NS	NS	NS	NS	NS	NS	NS	NS
o-Xylene	NS	NS	NS	NS	NS	NS	NS	NS
p-Chlorotoluene	NS	NS	NS	NS	NS	NS	NS	NS
p-Isopropyltoluene	NS	NS	NS	NS	NS	NS	NS	NS
sec-Butylbenzene	NS	NS	NS	NS	NS	NS	NS	NS
tert-Butylbenzene	NS	NS	NS	NS	NS	NS	NS	NS
trans-1,2-Dichloroethene	NS	NS	NS	NS	NS	NS	NS	NS
Thallium	0.94 U	0.62 U	0.87 J	0.88 U	0.75 U	NS	0.8 U	NS
Semivolatile Organic Compounds (UG/KG)								
1,2,4-Trichlorobenzene	NS	440 UJ	510 UL	480 U	460 U	460 UJ	440 U	510 U
1,2-Dichlorobenzene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
1,3-Dichlorobenzene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
1,4-Dichlorobenzene	NS	440 UJ	510 UL	480 U	460 U	460 UJ	440 U	510 U
2,2'-Oxybis(1-chloropropane)	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
2,4,5-Trichlorophenol	1,300 U	1,100 U	1,300 U	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
2,4,6-Trichlorophenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
2,4-Dichlorophenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
2,4-Dimethylphenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
2,4-Dinitrophenol	1,300 U	1,100 U	1,300 U	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
2,4-Dinitrotoluene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
2,6-Dinitrotoluene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
2-Chloronaphthalene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
2-Chlorophenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD09-2.5	OW15-SD10-5.5	OW15-SD11-2.5	OW15-SD12-5.5	OW15-SD13-7.0	OW15-SD14-7.0	OW15-SD15-7.0	OW15-SD16-0.0
2-Methylnaphthalene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
2-Methylphenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
2-Nitroaniline	NS	1,100 U	1,300 UL	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
2-Nitrophenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
3,3'-Dichlorobenzidine	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
3-Nitroaniline	NS	1,100 U	1,300 UL	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
4,6-Dinitro-2-methylphenol	1,300 U	1,100 U	1,300 U	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
4-Bromophenyl-phenylether	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
4-Chloro-3-methylphenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
4-Chloroaniline	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
4-Chlorophenyl-phenylether	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
4-Methylphenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
4-Nitroaniline	NS	1,100 U	1,300 UL	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
4-Nitrophenol	1,300 U	1,100 U	1,300 U	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
Acenaphthene	6.6 U	17	6.6 U	18.8 U	90 U	9.108 U	6.6 UJ	1,132
Acenaphthylene	33 U	43.6 U	33 U	10.8 J	450 U	45.54 U	33 UJ	510 U
Anthracene	14.2	4.36 U	2.94 J	9.4 U	45 U	10.706 J	7.39 J	497.739 UJ
Benzo(a)anthracene	2.01	3.3	0.746	8.31	7.55	2.061 J	1.73 J	189.241 J
Benzo(a)pyrene	3.3 U	7.55	3.3 U	9.4 U	24.2 J	4.554 U	3.3 UJ	497.739 U
Benzo(b)fluoranthene	13 U	17.2 U	13 U	37 U	177 U	17.94 U	13 UJ	85 J
Benzo(g,h,i)perylene	6.6 U	61.3	6.6 U	47.2	133	9.108 U	6.6 UJ	510 U
Benzo(k)fluoranthene	26 U	34.3 U	26 U	74.1 U	355 U	35.88 U	26 UJ	510 U
Butylbenzylphthalate	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Carbazole	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Chrysene	3.62	11.7	1.15	13.9	16.7	2.875 J	3.22 J	355.972 J
Di-n-butylphthalate	52 L	440 U	87 L	480 U	46 J	460 UJ	440 U	92 J
Di-n-octyl phthalate	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Dibenz(a,h)anthracene	6.6 U	8.71 U	6.6 U	58.2	90 U	9.108 U	6.6 UJ	510 U
Dibenzofuran	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Diethylphthalate	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	110 J
Dimethyl phthalate	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Fluoranthene	33 U	43.6 U	33 U	1,490	155 J	45.54 U	33 UJ	510 U
Fluorene	13 U	17.2 U	13 U	66.3	177 U	17.94 U	13 UJ	510 U
Hexachlorobenzene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Hexachlorobutadiene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Hexachlorocyclopentadiene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Hexachloroethane	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Indeno(1,2,3-cd)pyrene	26.4	1.97 J	13 U	37 U	8.83 J	17.94 U	13 UJ	510 U
Isophorone	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Naphthalene	66 U	87.1 U	66 U	188 U	460 U	91.08 U	66 UJ	510 U
Nitrobenzene	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD09-2.5	OW15-SD10-5.5	OW15-SD11-2.5	OW15-SD12-5.5	OW15-SD13-7.0	OW15-SD14-7.0	OW15-SD15-7.0	OW15-SD16-0.0
Pentachlorophenol	1,300 U	1,100 U	1,300 U	1,200 U	1,100 U	1,200 UJ	1,100 U	1,300 U
Phenanthrene	1.7 U	6.18	1.7 U	8.64	23.2 U	2.141 J	1.96 J	256.411 U
Phenol	510 U	440 U	510 U	480 U	460 U	460 UJ	440 U	510 U
Pyrene	0.566	1.15	0.17 U	2.09	2.02 J	0.235 U	0.287 J	51.363
bis(2-Chloroethoxy)methane	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
bis(2-Chloroethyl)ether	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
bis(2-Ethylhexyl)phthalate	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	83 B
n-Nitroso-di-n-propylamine	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
n-Nitrosodiphenylamine	NS	440 U	510 UL	480 U	460 U	460 UJ	440 U	510 U
Pesticide/PCBs (UG/KG)								
4,4'-DDD	NS	NS	NS	NS	NS	NS	NS	NS
4,4'-DDE	NS	NS	NS	NS	NS	NS	NS	NS
4,4'-DDT	NS	NS	NS	NS	NS	NS	NS	NS
Aldrin	NS	NS	NS	NS	NS	NS	NS	NS
Aroclor-1016	NS	NS	NS	NS	NS	NS	NS	NS
Aroclor-1221	NS	NS	NS	NS	NS	NS	NS	NS
Aroclor-1232	NS	NS	NS	NS	NS	NS	NS	NS
Aroclor-1242	NS	NS	NS	NS	NS	NS	NS	NS
Aroclor-1248	NS	NS	NS	NS	NS	NS	NS	NS
Aroclor-1254	NS	NS	NS	NS	NS	NS	NS	NS
Aroclor-1260	NS	NS	NS	NS	NS	NS	NS	NS
Dieldrin	NS	NS	NS	NS	NS	NS	NS	NS
Endosulfan I	NS	NS	NS	NS	NS	NS	NS	NS
Endosulfan II	NS	NS	NS	NS	NS	NS	NS	NS
Endosulfan sulfate	NS	NS	NS	NS	NS	NS	NS	NS
Endrin	NS	NS	NS	NS	NS	NS	NS	NS
Endrin aldehyde	NS	NS	NS	NS	NS	NS	NS	NS
Endrin ketone	NS	NS	NS	NS	NS	NS	NS	NS
Heptachlor	NS	NS	NS	NS	NS	NS	NS	NS
Heptachlor epoxide	NS	NS	NS	NS	NS	NS	NS	NS
Methoxychlor	NS	NS	NS	NS	NS	NS	NS	NS
Toxaphene	NS	NS	NS	NS	NS	NS	NS	NS
alpha-BHC	NS	NS	NS	NS	NS	NS	NS	NS
alpha-Chlordane	NS	NS	NS	NS	NS	NS	NS	NS
beta-BHC	NS	NS	NS	NS	NS	NS	NS	NS
delta-BHC	NS	NS	NS	NS	NS	NS	NS	NS
gamma-BHC (Lindane)	NS	NS	NS	NS	NS	NS	NS	NS
gamma-Chlordane	NS	NS	NS	NS	NS	NS	NS	NS
Total Metals (MG/KG)								
Aluminum	24,200	4,950	22,500	9,990	2,690	3,880	3,100	29,500
Antimony	0.79 UL	0.52 UL	0.74 UL	0.85 L	0.63 UL	0.6 U	0.68 UL	0.65 U

Table A-2-3
Analytical Results - Sediment - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SD09-2.5		OW15-SD10-5.5		OW15-SD11-2.5		OW15-SD12-5.5		OW15-SD13-7.0		OW15-SD14-7.0		OW15-SD15-7.0		OW15-SD16-0.0	
Arsenic	3.4		4.7		4.1		2.6	J	2.1	J	3.1		4.1		3.2	
Barium	74.8		23.9	J	88.7		47.1	J	13.3	J	20.6	J	14.8	J	150	
Beryllium	0.5	J	0.16	J	0.79	J	0.37	J	0.1	J	0.16	J	0.13	J	0.98	J
Cadmium	0.09	U	0.06	U	0.08	U	0.15	J	0.07	U	0.08	U	0.08	U	0.46	B
Calcium	452	J	352	J	1,090	J	693	J	233	J	328	B	255	J	2,610	
Chromium	39.9		10.2		41.2		15.1		6.8		8.3		6.8		37.1	
Cobalt	4	J	1.9	J	3.5	J	2.9	J	1.9	J	0.97	J	1.4	J	5.9	J
Copper	8.8		4.4	J	11.9		7.8		2.8	J	3.5	B	3.8	J	16	
Cyanide	0.42		0.27	U	0.32	U	0.32	U	0.28	U	0.4		0.27	U	0.31	U
Iron	24,700		5,000		25,600		6,280		2,400		3,410		3,660		13,100	
Lead	8		3.7		9.6		13.1		2.4		3	J	2.4		72.7	J
Magnesium	2,060		662	J	1,670		883	J	416	J	495	J	471	J	2,100	
Manganese	46.3		20		35.1		28.1		15.6		14.7		16.4		60.7	
Mercury	0.03	J	0.02	U	0.02	U	0.04	J	0.02	U	0.02	U	0.02	U	0.1	
Nickel	12.1		4.3	J	11.2		6.9	J	3	J	3.1	J	2.7	J	16.9	
Potassium	848	J	477	J	957	J	474	J	335	J	357	J	355	J	1,070	J
Selenium	0.76	U	0.5	U	0.71	U	0.71	U	0.61	U	0.73	U	0.65	U	0.8	U
Silver	0.26	U	0.17	U	0.25	U	0.25	U	0.21	U	0.19	U	0.23	U	0.21	U
Sodium	52.3	J	42	J	101	J	90.8	J	34.8	U	44.1	U	37.1	U	92.9	J
Vanadium	40.3		10.4		41.2		15.7		6.3	J	8	J	7.6	J	41.4	
Zinc	28.1	J	11.5	J	28.5	J	18.1	J	8.6	J	8.2	J	10.1	J	77.6	J

Table A-2-4
Analytical Results - Surface Soil - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SS06		OW15-SS07		OW15-SS08		OW15-SS09	
Volatile Organic Compounds (ug/kg)								
1,1,1-Trichloroethane	12	U	12	U	12	U	11	U
1,1,2,2-Tetrachloroethane	12	U	12	U	12	U	11	U
1,1,2-Trichloroethane	12	U	12	U	12	U	11	U
1,1-Dichloroethane	12	U	12	U	12	U	11	U
1,1-Dichloroethene	12	U	12	U	12	U	11	U
1,2-Dichloroethane	12	U	12	U	12	U	11	U
1,2-Dichloroethene (total)	12	U	12	U	12	U	11	U
1,2-Dichloropropane	12	U	12	U	12	U	11	U
2-Butanone	12	U	12	U	12	U	11	U
2-Hexanone	12	U	12	U	12	U	11	U
4-Methyl-2-pentanone	12	U	12	U	12	U	11	U
Acetone	12	UJ	12	UJ	12	UJ	11	UJ
Benzene	12	U	12	U	12	U	11	U
Bromodichloromethane	12	U	12	U	12	U	11	U
Bromoform	12	U	12	U	12	U	11	U
Bromomethane	12	U	12	U	12	U	11	U
Carbon disulfide	12	U	12	U	12	U	11	U
Carbon tetrachloride	12	U	12	U	12	U	11	U
Chlorobenzene	12	U	12	U	12	U	11	U
Chloroethane	12	U	12	U	12	U	11	U
Chloroform	1	B	1	B	12	U	2	B
Chloromethane	12	U	12	U	12	U	11	U
Dibromochloromethane	12	U	12	U	12	U	11	U
Ethylbenzene	12	U	12	U	12	U	11	U
Methylene chloride	10	B	11	B	11	B	10	B
Styrene	12	U	12	U	12	U	11	U
Tetrachloroethene	12	U	12	U	12	U	11	U
Toluene	12	U	12	U	12	U	11	U
Trichloroethene	12	U	12	U	12	U	11	U
Vinyl chloride	12	U	12	U	12	U	11	U
Xylene, total	12	U	12	U	12	U	11	U
cis-1,3-Dichloropropene	12	U	12	U	12	U	11	U
trans-1,3-Dichloropropene	12	U	12	U	12	U	11	U

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Table A-2-4
Analtyical Results - Surface Soil - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SS06		OW15-SS07		OW15-SS08		OW15-SS09	
Semivolatile Organic Compounds (ug/kg)								
1,2,4-Trichlorobenzene	390	U	4200	U	420	U	380	U
1,2-Dichlorobenzene	390	U	4200	U	420	U	380	U
1,3-Dichlorobenzene	390	U	4200	U	420	U	380	U
1,4-Dichlorobenzene	390	U	4200	U	420	U	380	U
2,2'-Oxybis(1-chloropropane)	390	U	4200	U	420	U	380	U
2,4,5-Trichlorophenol	980	U	10000	U	1000	U	950	U
2,4,6-Trichlorophenol	390	U	4200	U	420	U	380	U
2,4-Dichlorophenol	390	U	4200	U	420	U	380	U
2,4-Dimethylphenol	390	U	4200	U	420	U	380	U
2,4-Dinitrophenol	980	U	10000	U	1000	U	950	U
2,4-Dinitrotoluene	390	U	4200	U	420	U	380	U
2,6-Dinitrotoluene	390	U	4200	U	420	U	380	U
2-Chloronaphthalene	390	U	4200	U	420	U	380	U
2-Chlorophenol	390	U	4200	U	420	U	380	U
2-Methylnaphthalene	390	U	700	J	420	U	380	U
2-Methylphenol	390	U	4200	U	420	U	380	U
2-Nitroaniline	980	U	10000	U	1000	U	950	U
2-Nitrophenol	390	U	4200	U	420	U	380	U
3,3'-Dichlorobenzidine	390	U	4200	U	420	U	380	U
3-Nitroaniline	980	U	10000	U	1000	U	950	U
4,6-Dinitro-2-methylphenol	980	U	10000	U	1000	U	950	U
4-Bromophenyl-phenylether	390	U	4200	U	420	U	380	U
4-Chloro-3-methylphenol	390	U	4200	U	420	U	380	U
4-Chloroaniline	390	U	4200	U	420	U	380	U
4-Chlorophenyl-phenylether	390	U	4200	U	420	U	380	U
4-Methylphenol	390	U	4200	U	420	U	380	U
4-Nitroaniline	980	U	10000	U	1000	U	950	U
4-Nitrophenol	980	U	10000	U	1000	U	950	U
Acenaphthene	3671		33939	J	420	U	717	J
Acenaphthylene	390	U	4099	U	420	U	380	U
Anthracene	389	U	3200	J	414	UJ	70	J
Benzo(a)anthracene	1108	J	22954	J	174	J	320	J
Benzo(a)pyrene	250	J	29000	J	414	U	460	J
Benzo(b)fluoranthene	48510	J	40000		420	U	420	J

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Table A-2-4
Analtyical Results - Surface Soil - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SS06		OW15-SS07		OW15-SS08		OW15-SS09	
Benzo(g,h,i)perylene	160	J	203419		420	U	400	J
Benzo(k)fluoranthene	150	J	16000	J	420	U	280	J
Butylbenzylphthalate	390	U	4200	U	420	U	380	U
Carbazole	390	U	2000	J	420	U	44	J
Chrysene	2016	J	44087	J	346	J	330	J
Di-n-butylphthalate	65	J	4200	U	420	U	380	U
Di-n-octyl phthalate	390	U	4200	UJ	420	U	380	UJ
Dibenz(a,h)anthracene	390	U	33753	J	420	U	380	UJ
Dibenzofuran	390	U	830	J	420	U	380	U
Diethylphthalate	70	J	4200	U	57	J	130	J
Dimethyl phthalate	390	U	4200	U	420	U	380	U
Fluoranthene	95662	J	279888	J	14611		410	J
Fluorene	1533	U	1561141	J	420	U	380	U
Hexachlorobenzene	390	U	4200	U	420	U	380	U
Hexachlorobutadiene	390	U	4200	U	420	U	380	U
Hexachlorocyclopentadiene	390	U	4200	U	420	U	380	U
Hexachloroethane	390	U	4200	U	420	U	380	U
Indeno(1,2,3-cd)pyrene	140	J	16000	J	420	U	340	J
Isophorone	390	U	4200	U	420	U	380	U
Naphthalene	390	U	2700	J	420	U	380	U
Nitrobenzene	390	U	4200	U	420	U	380	U
Pentachlorophenol	980	U	10000	U	1000	U	950	U
Phenanthrene	1743		16279	J	213	U	290	J
Phenol	390	U	4200	U	420	U	380	U
Pyrene	321	J	21000		46		710	
bis(2-Chloroethoxy)methane	390	U	4200	U	420	U	380	U
bis(2-Chloroethyl)ether	390	U	4200	U	420	U	380	U
bis(2-Ethylhexyl)phthalate	51	B	4200	U	420	U	380	U
n-Nitroso-di-n-propylamine	390	U	4200	U	420	U	380	U
n-Nitrosodiphenylamine	390	U	4200	U	420	U	380	U
Pesticides/ PCBs (ug/kg)								
4,4'-DDD	3.9	U	4.1	U	4.2	U	3.8	U
4,4'-DDE	3.9	U	4.1	U	4.2	U	0.67	J
4,4'-DDT	3.9	U	4.1	U	4.2	U	1.7	J
Aldrin	2	U	2.1	U	2.1	U	1.9	U

Table A-2-4
Analtyical Results - Surface Soil - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SS06		OW15-SS07		OW15-SS08		OW15-SS09	
Aroclor-1016	39	U	41	U	42	U	38	U
Aroclor-1221	79	U	83	U	83	U	75	U
Aroclor-1232	39	U	41	U	42	U	38	U
Aroclor-1242	39	U	41	U	42	U	38	U
Aroclor-1248	39	U	41	U	42	U	38	U
Aroclor-1254	39	U	41	U	450		38	U
Aroclor-1260	39	U	41	U	420		38	U
Dieldrin	9.2		2.1	J	4.2	U	15	
Endosulfan I	2	U	2.1	U	2.1	U	1.9	U
Endosulfan II	3.9	U	4.1	U	4.2	U	3.8	U
Endosulfan sulfate	3.9	U	4.1	U	4.2	U	3.8	U
Endrin	3.9	U	4.1	U	4.2	U	3.8	U
Endrin aldehyde	3.9	U	4.1	U	4.2	U	3.8	U
Endrin ketone	3.9	U	4.1	U	4.2	U	3.8	U
Heptachlor	2	U	2.1	U	2.1	U	1.9	U
Heptachlor epoxide	2	U	2.1	U	2.1	U	1.9	U
Methoxychlor	20	U	21	U	21	U	19	U
Toxaphene	200	U	210	U	210	U	190	U
alpha-BHC	2	U	2.1	U	2.1	U	1.9	U
alpha-Chlordane	2	U	2.1	U	2.1	U	1.9	U
beta-BHC	2	U	2.1	U	2.1	U	1.9	U
delta-BHC	2	U	2.1	U	2.1	U	1.9	U
gamma-BHC (Lindane)	2	U	2.1	U	2.1	U	1.9	U
gamma-Chlordane	2	U	2.1	U	2.1	U	1.9	U
Metals (MG/KG)								
Aluminum	14400		14300		13100		9220	
Antimony	0.48	U	0.55	U	0.52	U	0.39	U
Arsenic	1.8	J	1.7	J	2	J	1.5	J
Barium	63.4		55.7		58.8		46.4	
Beryllium	0.47	J	0.47	J	0.44	J	0.31	J
Cadmium	0.17	B	0.1	B	0.19	B	0.73	B
Calcium	1230		925	J	850	J	14300	
Chromium	19		19.6		19.3		10.8	
Cobalt	2.8	J	2.8	J	2.9	J	1.7	J
Copper	8.1	B	8.9	B	8.5	B	8.4	B

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Table A-2-4
Analtyical Results - Surface Soil - SWMU 15
NAS Oceana, Virginia Beach, VA

Chemical Name	OW15-SS06		OW15-SS07		OW15-SS08		OW15-SS09	
Cyanide	0.27	U	0.28	U	0.26	U	0.2	U
Iron	6970		6980		7470		5270	
Lead	22.3	J	20	J	16	J	118	J
Magnesium	954	J	1050	J	984	J	1270	
Manganese	37.2		30.5		31.1		52.4	
Mercury	0.05		0.05		0.04		0.03	J
Nickel	9.1		10.3		9.5		6.2	J
Potassium	422	J	443	J	503	J	311	J
Selenium	0.76	B	0.86	B	0.81	B	0.55	B
Silver	0.62	J	0.17	U	0.16	U	0.12	U
Sodium	35.5	U	40.4	U	38	U	42.8	J
Vanadium	20.1		19.6		19.7		13.1	
Zinc	20	J	20.9	J	22	J	18.2	J

Appendix B
Receptor Profiles

Deer Mouse (*Peromyscus maniculatus*)

The deer mouse inhabits nearly all types of dry-land habitats within their range. They are opportunistic feeders and eat seeds, arthropods, some green vegetation, roots, and fruit. For the purposes of this risk assessment, it was assumed that soil invertebrates comprised 45 percent of their diet, while plants comprised 53 percent of their diet. Soil ingestion comprised 2 percent of their diet (Beyer et al. 1994). The deer mouse has an average food ingestion rate of 0.00051 kg/day (dry weight basis; USEPA 1993). Their average water ingestion rate is 0.00302 L/day (USEPA 1993). Average body weights are approximately 0.0168 kg (Silva and Downing 1995). Breeding adults in a mixed/deciduous forest in Virginia have a home range of 0.058 ha for males and 0.061 ha for females (Wolff 1985).

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Meadow Vole (*Microtus pennsylvanicus*)

Meadow voles inhabit grassy fields, marshes, bogs, and other wet habitats. They are primarily terrestrial but they are strong swimmers. Their diet is composed mostly of plants but voles are also known to eat insects and animal matter . For the purposes of this risk assessment, it was assumed that plants comprised 95.6 percent and soil invertebrates comprised 2.0 percent of the vole's diet. Soil ingestion comprises 2.4 percent of their diet (Beyer et al. 1994). The meadow vole's home range varies from 0.0002 to 0.014 hectares depending on the sex of the vole and the season (Douglass 1976). Meadow voles weigh an average of approximately 0.0428 kg (Silva and Downing 1995). An average food ingestion rate of 0.00209 kg/day (dry weight basis) and average water ingestion rate of 0.00899 L/day were reported in the literature (USEPA 1993).

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Mink (*Mustela vison*)

Mink are distributed throughout most of the continental United States and Canada except in the extreme northern portion of Canada and in the arid areas of the southwestern United States (USEPA 1993, Linscombe et al. 1982). The composition of mink diets varies considerably according to season, prey availability, and habitat type. Mink are opportunistic feeders, with prey species generally taken in relation to their availability (relative abundance and accessibility) (Allen 1986). In general, small mammals and fish are the two principal components of the diet in most areas, seasons, and habitats (Wren 1991). Small mammals (mice, voles, muskrats, and rabbits) typically compose about 50 percent of the annual diet and become increasingly important in fall and winter, especially in northern areas where water bodies freeze solid for portions of the year. Fish are important prey items, especially in fall and winter, but their contribution to the diet is variable (4 to 85 percent). For the purposes of this risk assessment, fish comprised 94 percent of the mink's diet, aquatic plants comprised 1 percent, and aquatic invertebrates comprised 5 percent of their diet. An average body weight of 0.777 kg (Silva and Downing 1995), a food ingestion rate of 0.02587 kg/day, and a water ingestion rate of 0.02176 L/day were used in this risk assessment (USEPA 1993).

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Raccoon (*Procyon lotor*)

Raccoons are found across most of the United States primarily in forested areas. They feed in all types of wetlands from swamps to salt marshes. Adult raccoons weigh between 4.2 and 8.3 kg (Sanderson 1984). The average (5.94 kg) body weight for the raccoon was used in this risk assessment (USEPA 1993). Raccoons are omnivorous and will feed on fruits, nuts, grains, crayfish, frogs, clams, insects, birds, eggs, and small rabbits (White 1989). For this risk assessment, it was assumed that invertebrates comprised 43.6 percent, plants comprised 40 percent, and fish comprised 7 percent of the raccoon's diet. Beyer et al. (1994) estimated that sediment makes up 9.4 percent of the raccoon's diet. Their home range varies from 39 to 65 hectares (Lotze 1979). An average food ingestion rate of 0.10003 kg/day (dry weight basis) was used in this risk assessment (Conover 1989). An average water ingestion rate of 0.49209 L/day was used in the risk assessment (USEPA 1993).

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Red Fox (*Vulpes vulpes*)

Red foxes are the most widely distributed carnivore in the world. They utilize many different types of habitats including salt marshes, cropland, rolling farmland, brush, pastures, hardwood stands, and coniferous forests. Their diet consists primarily of small mammals including meadow voles, mice, and rabbits. In the salt marsh, they forage upon resident animals including voles, muskrats, small marsh birds, and invertebrates. They also consume plant material mainly in the summer and fall when fruits, berries, and nuts become available (USEPA 1993). For the purposes of this risk assessment, in a terrestrial habitat it was assumed that small mammals comprised the majority of the fox's diet; soil ingestion accounts for about 2.8 percent of the diet (Beyer et al. 1994). An adult red fox body weight ranges from 3.2 to 5.25 kg (Merritt 1987; Storm et al. 1976). The average (4.06 kg) body weight for the red fox was used in this risk assessment (Silva and Downing 1995). The average food ingestion rate (0.12308 kg/day on a dry weight basis) (Sample and Suter 1994) and an average water ingestion rate of 0.34939 L/day (USEPA 1993) was used in the risk assessment. Their year-round home range is 717 hectares (Ables 1969).

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Short-tailed Shrew (*Blarina brevicauda*)

Shrews are small insectivorous mammals that have a high metabolic rate and can eat approximately their body weight in food each day. Short-tailed shrews eat insects, worms, snails, and other invertebrates and also may eat mice, voles, frogs, and other vertebrates (Robinson and Brodie 1982). For the purposes of this risk assessment, it was assumed that soil invertebrates comprised the majority of the shrew's diet. Short-tailed shrews can measure 8 to 10 cm in length and weigh from 0.015 to 0.022 kg (Schlesinger and Potter 1974; George et al. 1986). The average (0.01687 kg) body weight was used in this risk assessment (USEPA 1993). A food ingestion rate of 0.00149 kg/day (dry weight basis) and a water ingestion rate of 0.00376 L/day was used (USEPA 1993). The shrew's home range varies from 0.1 to 0.39 hectares and is smaller during the winter (Buckner 1996).

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American Kestrel (*Falco sparverius*)

The American kestrel is one of the most common falcons in North America. They are found in open to semi-open areas and near the edges of groves. American kestrels eat small mammals, birds, and invertebrates. This risk assessment assumed a diet of 38 percent invertebrates, 60 percent small mammals, and 2 percent soil. American kestrels generally weigh just over one tenth of a kilogram. For the purpose of this risk assessment, an average body weight of 0.114 kg was used (USEPA 1993). Kestrels have a average food and water ingestion rate of 0.00882 kg/day (dry weight basis) and 0.01377 L/day respectively (USEPA 1993). Kestrels have a home range of 323.57 acres (Craighead and Craighead 1956).

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U.S. Environmental Protection Agency (USEPA). 1993. *Wildlife exposure factors handbook. Volume I of II.* EPA/600/R-93/187a.

American Robin (*Turdus migratorius*)

Robins live in a variety of habitats, including woodlands, swamps, suburbs, and parks. Robins forage on the ground in open areas, along edge habitats, or along the edges of streams. They forage along the ground for ground-dwelling invertebrates and search for fruit and foliage-dwelling insects in low tree branches (Malmborg and Willson 1988). For the purposes of this risk assessment, it was assumed that soil invertebrates comprise 51.6 percent, plants comprise 43.6 percent and soil comprises 4.8 percent of the robin's diet (USEPA 1993; Beyer et al. 1994). The size of their home range varies from 0.11 to 0.42 hectares (Pitts 1984; Howell 1942). A average body weight of 0.0773 kg (USEPA 1993) was used in the risk calculations. Their average food ingestion rate is 0.00552 kg/day (dry weight basis) (Levey and Karasov 1989). Their water ingestion rate is 0.01062 L/day (USEPA 1993).

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Great Blue Heron (*Ardea herodias*)

The great blue heron occupies a variety of freshwater and marine areas, including brackish marshes, coastal wetlands, lakes, and rivers where small fish are abundant in shallow areas. Fish are preferred prey, but they also feed on amphibians, reptiles, insects, crustaceans, birds, and mammals (Alexander 1977; Peifer 1979). For purposes of this risk assessment, it was assumed that fish comprised 100 percent of the heron's diet. Heronries may range up to 7 to 8 km from foraging areas, although travel of up to 20 km is known. A home range of 8.4 hectares has been reported (Bayer 1978). The average body weight of 2.23 kg was used in the risk calculations (Quinney 1982). Their average food and water ingestion rates are 0.39306 kg/day (dry weight basis) and 0.10098 L/day, respectively (USEPA 1993).

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U.S. Environmental Protection Agency (USEPA). 1993. *Wildlife exposure factors handbook. Volume I of II.* EPA/600/R-93/187a.

Quinney, T.E. 1982. Growth, diet, and mortality of nestling great blue herons. *Wilson Bulletin.* 94:571-577.

Mallard (*Anas platyrhynchos*)

The mallard is the most widespread and abundant duck in North America (USEPA 1993). This species occurs most frequently in shallow wetland habitats, preferring freshwater to saltwater or brackish water bodies, and also commonly occurs in agricultural and suburban areas. The mallard reaches its highest breeding densities in the prairie pothole region of northern North and South Dakota and southern Saskatchewan, Alberta, and Manitoba (Bellrose 1980; Palmer 1976).

A food ingestion rate of 0.06471 kg/day (dry weight basis) was used in this risk assessment (USEPA 1993 - allometric equation based on mean body weight). USEPA (1993) has estimated mallard water ingestion rates at 5.5 to 5.8 percent of body weight per day (0.06581 L/day). A average body weight of 1.177 kg was used in this risk assessment (Bellrose 1980).

The habitats used and the foods consumed by mallards vary by season, location, and the sex of the bird. On an annual basis, mallards normally consume about 90 percent plant material and 10 percent animal matter. Of the animal matter consumed, most is aquatic invertebrates but small quantities of fish (typically 5 percent or less of the total diet) may also be consumed (Newell et al. 1987; Palmer 1976). Invertebrates consumed include aquatic insects, mollusks (mostly snails and small bivalves), and crustaceans. Mallards may also consume earthworms, spiders, tadpoles, frogs, small fish, and fish eggs in small quantities (Palmer 1976). Mallards also consume small amounts of grit to aid in the digestion of foods and also ingest soil or sediment incidental to feeding. In fall, the crop contents of mallards were found to include approximately 0.1 percent grit (Junca et al. 1962). Beyer et al. (1994) estimate that about 3.3 percent of the total diet consists of soil or sediment ingested incidentally while feeding.

On the breeding grounds, the home range of males (240 to 620 ha) is generally larger than for females (135 to 540 ha). The home range of mallards in winter consists of the distance they will fly between roosting and feeding locations. This distance is typically less than 8 km (Allen 1987), although maximum distances are 15 to 20 km (rarely 50 to 60 km).

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U.S. Environmental Protection Agency (USEPA). 1993. *Wildlife exposure factors handbook. Volume I of II.* EPA/600/R-93/187a.

Marsh Wren (*Cistothorus palustris*)

The marsh wren is common near freshwater marshes and coastal wetlands. Body weight varies seasonally. The average body weight for an adult is 0.01125 kg (Dunning 1993). The marsh wren feeds primarily on aquatic invertebrates and other insects, which they glean from the surface of vegetation. Organisms that are aquatic for all or part of their lives are an important component of the marsh wren's diet. For purposes of this risk assessment, it was assumed that aquatic invertebrates comprised 95 percent of the wren's diet. A sediment ingestion rate of 5 percent was assumed. An average food ingestion rate of 0.00249 kg/day (dry weight basis) and average water ingestion rate of 0.00292 L/day were used in this risk assessment (USEPA 1993). The home range for the adult male wren is 0.17 hectares (Verner 1965).

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U.S. Environmental Protection Agency (USEPA). 1993. *Wildlife exposure factors handbook. Volume I of II.* EPA/600/R-93/187a.

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Appendix C
Chemical Profiles

Inorganics

Aluminum

Aluminum occurs naturally and makes up about 8 percent of the earth's crust. In the environment, aluminum binds to air particles; dissolves in lakes, streams, and rivers depending on water quality; and can be taken up into plants from soil. The direct toxic potential of aluminum is low compared to that of many other metals (Scheuhammer 1987). The toxicity of aluminum has been shown to vary widely with water hardness and pH (Ingersoll et al. 1990; Woodard et al. 1989). The chronic toxicity of orally ingested aluminum in birds and mammals is probably more a function of its disruptive effects on calcium and phosphorus homeostasis than direct cytotoxicity of aluminum itself (Scheuhammer 1987). High levels of aluminum in the diet may cause decreased growth rates, bone abnormalities, and muscle weakness concurrent with marked disturbances of calcium and phosphorus metabolism. Studies using high levels in mice and rabbits show that aluminum may cause delays in skeletal and neurological development in young animals (ATSDR 1992). Studies of the possible aetiologic role of aluminum in breeding impairment of wild passerines reported severe eggshell defects, reduced clutch sizes, and high incidence of mortality in pied flycatchers and other species of small passerines nesting by the shore of an acid-stressed Swedish lake (Nyholm and Myhrberg 1977; Nyholm 1981). The source of the dietary ingestion of aluminum was thought to be the emergent insect biomass utilized as a food source by the shore-nesting flycatchers.

A literature search was conducted on the toxicological effects of aluminum ingestion to mammals. A 390-day reproductive study conducted on mice indicated a chronic oral toxicity dose of 193 mg/kg/day of aluminum (Ondreicka et al. 1966). The dose was considered to be a chronic LOAEL because there were no effects on the number of litters or number of offspring per litter, but the growth of generations 2 and 3 was significantly reduced. A chronic NOAEL of 19.3 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1 (ATSDR 1990). A 6-month reproductive study with dogs (ATSDR 1990) indicated a chronic LOAEL of 600 mg/kg/day. A chronic NOAEL of 60 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A literature search was conducted on the toxicological effects of aluminum to birds. A 4-month reproductive study conducted with ringed doves indicated no chronic oral toxicity at a dose of 1000 ppm (Carriere et al. 1986). This dose was considered to be a chronic NOAEL because no significant differences were observed at the 1000 ppm dose level and the study considered exposure over 4 months including a critical life stage (reproduction). The dose was converted to a final NOAEL of 109.7 mg/kg/day (Sample et al. 1996). A chronic LOAEL of 1097 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for aluminum*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Carriere, D., K. Fischer, D. Peakall, and P. Angehrn. 1986. Effects of dietary aluminum in combination with reduced calcium and phosphorus on the ring dove (*Streptopelia risoria*). *Water, Air, and Soil Poll.* 30: 757-764.

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Ondreicka, R., E. Ginter, and J. Kortus. 1966. Chronic toxicity of aluminum in rats and mice and its effects on phosphorus metabolism. *Brit. J. Indust. Med.* 23: 305-313.

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Antimony

Antimony is a silvery-white metal that is found in the earth's crust. Antimony ores are mined and then mixed with other metals to form antimony alloys or combined with oxygen to form antimony oxide. Antimony is released to the environment from natural sources and from industry. Most antimony ends up in soil, where it attaches strongly to particles that contain iron, manganese, or aluminum. Antimony is found at low levels in some rivers, lakes, and streams.

In short-term studies, animals that inhaled high levels of antimony had lung, heart, liver, and kidney damage and some died. In long-term studies, animals that inhaled low levels of antimony suffered eye irritation, hair loss, lung damage, and heart problems. Reproductive problems in rats have been caused by inhalation of high levels of antimony for a 3-month period. Long-term animal studies have reported liver damage and blood changes when animals ingested antimony (ATSDR 1992).

A literature search was conducted on the toxicological effects of antimony ingestion to mammals. A 1-year study conducted on the effects of antimony on the growth, survival, and tissue levels in mice indicated a chronic oral toxicity dose of 5 ppm (Schroeder et al. 1968). This dose was converted to 1.25 mg/kg/day and considered a chronic LOAEL because median life span was reduced among female mice exposed to the 5 ppm dose level (Sample et al. 1996). A chronic NOAEL of 0.125 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A 6-week study with northern bobwhites, conducted during a critical life stage (reproduction), showed chronic oral toxicity at a dose of 47400 mg/kg/day (Opresko et al. 1993). This dose was considered a chronic LOAEL. A chronic NOAEL of 4740 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for antimony*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Opresko, D.M., B.E. Sample, and G.W. Suter II. 1993. *Toxicological benchmarks for wildlife.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86.

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Arsenic

Arsenic tends to be widespread in the environment (Woolson 1975) and is constantly being oxidized, reduced, or mobilized (Eisler 1988). Arsenic is readily adsorbed onto sediments with high organic matter. Adsorption depends on the arsenic concentration, sediment characteristics, pH, and the ionic concentration of other compounds (Eisler 1988). Arsenate (pentavalent, As+5) is the predominant arsenic form in oxygenated water and arsenite (trivalent, As+3) is the predominant arsenic form under anaerobic conditions (USEPA 1981).

Arsenic is not significantly concentrated in aquatic invertebrates. Arsenic may be bioaccumulated by lower trophic level organisms; however, data does not indicate that significant biomagnification occurs (USEPA 1985).

A literature search was conducted on the toxicological effects of arsenic ingestion to mammals. A 3-generation study on the reproductive effects of arsenite in mice determined a LOAEL of 1.26 mg/kg/day (Schroeder and Mitchner 1971). At this dose, mice displayed declining litter sizes. A chronic NOAEL of 0.126 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A literature search was conducted on the toxicological effects of arsenic ingestion to birds. In a 7-month study conducted by USFWS (1969) on male brown-headed cowbirds, four dietary dose levels were used. Doses of 675 and 225 ppm caused 100 percent mortality and doses of 75 (33.26 mg/kg) and 25 (11.09 mg/kg) ppm caused 20 percent and 0 percent mortality, respectively. The 75 and 25 ppm doses were considered the chronic LOAEL and NOAEL, respectively. A chronic NOAEL of 2.46 mg/kg/day and a LOAEL of 7.38 mg/kg/day were calculated from these data (Sample et al. 1996). Mallards exposed to arsenic in the diet for 128 days showed effects to survival at doses of 12.84 mg/kg/day (the estimated chronic LOAEL) with the NOAEL estimated at 5.14 mg/kg/day (Sample et al. 1996).

Eisler, R. 1988. *Arsenic hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish and Wildlife Service Biological Report 85(1.12), Contaminant Hazard Reviews Report No. 12. 92 pp.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

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Barium

Barium occurs in nature combined with other chemicals such as sulfur, or carbon and oxygen. Some barium compounds dissolve easily in water and are found in lakes, rivers, and streams. Barium is found in most soils and foods at low levels. Fish and aquatic organisms accumulate barium in their tissues (ATSDR 1992). Studies on animals have shown that ingesting low levels of barium over the long term causes increased blood pressure and heart changes (ATSDR 1992).

A 16-month study conducted with barium administered orally in water to rats was used to derive a chronic NOAEL (endpoints were growth and hypertension) of 5.1 mg/kg/day, while a second study with rats (endpoint was mortality) was used to derive a chronic LOAEL of 19.8 mg/kg/day (Sample et al. 1996).

In a study conducted by Johnson (1960) over a 4-week period, chicks were exposed to eight barium dose levels in their diet. Exposures of up to 2000 ppm produced no mortality. Chicks in the 4000 to 32000 ppm groups experienced 5 to 100 percent mortality, respectively. The 2000 and 4000 ppm doses were considered the chronic NOAEL and LOAEL, respectively. These dietary concentrations were converted to a chronic NOAEL of 208 mg/kg/day and a chronic LOAEL of 417 mg/kg/day (Sample et al. 1996).

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological Profile for Barium.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Johnson, D., Jr., A.L. Mehring, Jr., and H.W. Titus. 1960. Tolerance of chickens for barium. *Proc. Soc. Exp. Biol. Med.* 104: 436-438.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Beryllium

In nature, beryllium can be found, in compounds with other elements, in mineral rocks, coal, soil, and volcanic dust. It can enter water from rocks, soil, and industrial waste. Most beryllium compounds do not dissolve in water and settle to the bottom as particles. Fish are not known to accumulate beryllium in their bodies from the surrounding water to any great extent (ATSDR 1993). Based on animal studies, beryllium compounds may be considered carcinogens (ATSDR 1993).

A literature search was conducted on the toxicological effects of beryllium ingestion to mammals. A study conducted on the effect to longevity and weight loss from beryllium given orally in water to rats (lifetime exposures) indicated a chronic no effect level of 5 ppm, the only dose tested (Schroeder and Mitchner 1975). Exposure to 5 ppm beryllium in water did not reduce longevity, but weight loss by male rats was observed in the second and sixth month. Because weight loss was not considered an adverse effect, the 5 ppm dose level was considered to be a chronic NOAEL. The 5 ppm dietary concentration was converted to a daily dose of 0.66 mg/kg/day (Sample et al. 1996), which was considered the chronic NOAEL. A chronic LOAEL of 6.6 mg/kg/day was estimated by multiplying the NOAEL by an uncertainty factor of 10.

No dietary information was found on the toxicological effects of beryllium to birds.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for beryllium.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Schroeder, H.A. and M. Mitchener. 1975. Life-term studies in rats: effects of aluminum, barium, beryllium, and tungsten. *J. Nutr.* 105: 421-427.

Cadmium

Freshwater aquatic species are most sensitive to the toxic effects of cadmium, followed by marine organisms, birds, and mammals. Cadmium is a reproductive toxin in fish and other aquatic life. Adverse effects include carcinogenicity and teratogenicity. Other adverse effects in aquatic organisms include decreased oxygen utilization, bone marrow, heart, kidney, and vascular pressure. Diatoms and aquatic plants also show impaired growth and development at low concentrations of cadmium. Cadmium can concentrate in tissues and thus can accumulate in food chains. Vertebrates tend to accumulate cadmium in the kidney and liver (Eisler 1985).

A literature search was conducted on the toxicological effects of cadmium ingestion to mammals. A 6-week study conducted with rats indicated that oral doses of 1 mg/kg/day caused no reproductive impairment (Sample et al. 1996). This dose was considered a chronic NOAEL. Adverse reproductive (fetal) effects occurred at a dose of 10 mg/kg/day. This dose was considered a chronic LOAEL.

A similar study, conducted with dogs over a period of 3 months, indicated a NOAEL of 0.75 mg/kg/day because no adverse reproductive effects were observed (Loser and Lorke

1977). A chronic LOAEL was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

A 90-day study on the effects of cadmium administered orally in the diet on the reproduction of mallards indicated a chronic LOAEL of 20.03 mg/kg/day (White and Finley 1978). Ducks fed cadmium at this level were observed to produce significantly fewer eggs than those in lower dose groups. No adverse reproductive effects were observed at a dose of 1.45 mg/kg/day. This dose was considered to be a chronic NOAEL.

Eisler, R. 1985. *Cadmium hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish and Wildlife Service Biological Report 85(1.2), Contaminant Hazard Reviews. Report No. 2. 46 pp.

Loser, E. and D. Lorke. 1977. Semichronic oral toxicity of cadmium. II. Studies on dogs. *Toxicology.* 7:225-232.

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White, D.H. and M.T. Finley. 1978. Uptake and retention of dietary cadmium in mallard ducks. *Environ. Res.* 17:53-59.

Chromium

Chromium is a naturally occurring element. Chromium compounds are used in the chemical industry for metal finishing, manufacture of pigments, leather tanning, and water treatment. Chromium has been widely studied and its effects are well known.

A 3-month study on the effects of chromium on survival in rats indicated adverse effects at a dose of 131.4 mg/kg/day. This dose was considered to be a chronic LOAEL (Sample et al. 1996). A chronic NOAEL of 13.14 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 0.1.

A literature search was conducted on the toxicological effects of chromium ingestion to birds. A study conducted with American black ducks indicated that dietary levels of 5.0 mg/kg/day of chromium caused reduced duckling survival. This dose was considered a chronic LOAEL (Sample et al. 1996). A dose of 1.0 mg/kg/day was considered a chronic NOAEL because no adverse reproductive effects were observed at this level.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Cobalt

Rats exposed to cobalt in the diet for 69 days showed impaired reproduction at 50 mg/kg/day; this dose is considered a chronic LOAEL. A chronic NOAEL of 5 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1 (ATSDR 1992). Chickens exposed to cobalt in the diet for 14 days showed impaired growth at 14.7 mg/kg/day; this dose is considered a chronic LOAEL (Diaz et al. 1994). A chronic NOAEL of 1.47 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for cobalt.* July.

Diaz, G.J., R.J. Julian, and E.J. Squires. 1994. Lesions in broiler chickens following experimental intoxication with cobalt. *Avian Diseases.* 38:308-316.

Copper

Excess ingestion of copper leads to accumulation in tissues, mainly in the liver. When concentrations in the liver exceed a certain level, the metal is released into the blood causing hemolysis and jaundice. High levels of copper also inhibit essential metabolic enzymes (Demayo et al. 1982). Toxic symptoms appear when the liver accumulates 3 to 15 times the normal level of copper (Demayo et al. 1982).

Ruminants are the most sensitive mammalian species to the toxic effects of copper. Young animals retain more dietary copper than older animals and are more sensitive to copper toxicity (Venugopal and Luckey 1978). Copper is known to have adverse effects on aquatic organisms, but is dependent upon pH and hardness. Copper tends not to accumulate in most organisms or to biomagnify in food chains.

A 357-day study on the effects of copper on the reproduction of mink indicated increased mortality of mink kits at oral doses of 50, 100, and 200 ppm (Aulerich et al. 1982). The 50 ppm dose was converted to a chronic LOAEL of 15.14 mg/kg/day. A chronic NOAEL of 11.7 mg/kg/day was determined from the 25 ppm dietary concentration at which no adverse reproductive effects were observed.

A 10-week study on the effects of copper on the growth and mortality of day old chicks indicated reduced growth and increased mortality at a dietary concentration of 749 ppm (Mehring et al. 1960). This concentration, considered to be a chronic LOAEL, was converted to a daily dose of 61.7 mg/kg/day (Sample et al. 1996). No adverse effects were observed at a dietary concentration of 570 ppm. This concentration, considered to be a chronic NOAEL, was converted to a daily dose of 47 mg/kg/day.

Aulerich, R.J., R.K. Ringer, M.R. Bleavins et al. 1982. Effects of supplemental dietary copper on growth, reproduction performance and kit survival of standard dark mink and the acute toxicity of copper to mink. *J. Animal Sci.* 55:337-343.

DeMayo, A., M.C. Tyalor and K.W. Taylor. 1982. Effects of copper on humans, laboratory and farm animals, terrestrial plants and aquatic life. *CRC Critical Reviews in Environmental Control.* 12(3):183-255.

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Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Venugopal, B. and T.D. Luckey. 1978. *Metal toxicity in mammals, Volume 2.* Plenum Press, New York, N.Y.

Cyanide

Cyanide has a greater impact upon fish, in general, than upon invertebrates. Plants demonstrate a wide range of susceptibility. In general terms, plants will be protected at the same range considered safe for animals. Cyanide, which is readily metabolized by most organisms, does not bioaccumulate in food chains (Eisler 1991).

Eisler, R. 1991. *Cyanide hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish and Wildlife Service Biological Report 85(1.23), Contaminant Hazard Reviews Report No. 23. 55 pp.

Iron

Iron can have effects on plants. Chlorosis, the yellowing or dropping of leaves, can occur when iron, within alkaline soils, becomes insoluble and unavailable for uptake. At extremely high concentrations, iron has been reported to be toxic to livestock.

A literature search was conducted on the toxicological effects of iron ingestion to mammals and birds. The maximum tolerable level of iron for sheep and rabbits is 500 mg/kg/day (NAS 1980). The maximum tolerable level of iron for poultry is 1,000 mg/kg/day (NAS 1980). In the literature, *"maximum tolerable level"* is defined as that dietary level that, when fed for a limited period, will not impair animal performance (NAS 1980). Therefore, 500 mg/kg/day and 1,000 mg/kg/day were used as chronic LOAELs for mammals and birds, respectively. A chronic NOAEL was estimated by multiplying each LOAEL by an uncertainty factor of 0.1.

NAS (National Academy of Sciences). 1980. *Mineral tolerance of domestic animals.* National Research Council, Committee on Animal Nutrition, Board on Agriculture and Renewable Resources, Commission on Natural Resources. Washington, D.C.

Lead

Organic forms of lead are more bioavailable than inorganic forms, but microorganisms in streams are capable of transforming inorganic lead into organic forms. Soluble lead is toxic to all aquatic plant phyla. In plants, lead inhibits growth by reducing photosynthetic activity, mitosis, and water absorption. In the terrestrial environment, lead has been demonstrated to be toxic to birds, mammals, reptiles, and amphibians. Lead poisoning in birds is particularly well documented, but most lead poisoning in wild birds results from ingestion of lead pellets. In contrast, lead poisoning of birds, such as raptors, from biologically incorporated lead is considered unlikely. Lead is known to be toxic to mammalian species, but information on the effects on wild species is very limited. Toxic effects include mortality, reduced growth and reproduction, alterations of blood chemistry, lesions, and behavioral changes. Terrestrial vegetation also may be affected by elevated lead concentrations. Demonstrated effects include reduced photosynthesis, mitosis, and water absorption. Lead, however, appears to bind tightly to moist soil, and substantial amounts of lead typically need to accumulate before effects on plants are observed. Lead does not biomagnify to a great extent in food chains, although bioaccumulation in plants and animals has been extensively documented (Wixson and Davis 1993, Eisler 1988).

A study on three generations of rats fed lead acetate indicated a chronic NOAEL of 8 mg/kg/day (Azar et al. 1973). Rats fed this dose level were not observed to exhibit any adverse reproductive effects. Rats fed 80 mg/kg/day were observed to have reduced offspring weights and kidney damage in the young. This dose was considered to be a chronic LOAEL.

A 7-month study on the toxicological effects of lead ingestion in American kestrels found that an oral dose of 3.85 mg/kg/day did not cause any adverse reproductive effects (Sample et al. 1996); this dose was considered a chronic NOAEL. A chronic LOAEL of 38.5 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. A 12-week study with Japanese quail found that oral exposures to lead acetate in the diet did not have any adverse reproductive effects at doses of 1.13 mg/kg/day (chronic NOAEL) although adverse effects were observed at a dose of 11.3 mg/kg/day (chronic LOAEL; Sample et al. 1996).

Azar, A., H.J. Trochimowicz, and M.E. Maxwell. 1973. Review of lead studies in animals carried out at Haskell Laboratory: two-year feeding study and response to hemorrhage study. Pages 199-210 IN Barth, D et al. (eds). *Environmental health aspects of lead: proceedings, international symposium*. Commission of European Communities.

Eisler, R. 1988. *Lead hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish and Wildlife Service Biological Report 85(1.14), Contaminant Hazard Reviews Report No. 14. 134 pp.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Wixson, B.G. and B.E. Davis. 1993. *Lead in soil.* Lead in Soil Task Force, Science Reviews. Northwood. 132 pp.

Manganese

Manganese is a vital micronutrient in plants and animals. Plant leaves will turn yellow when manganese is not present is sufficient quantities. Manganese can be toxic to plants if irrigated with water and pH values are less than 6.0. Because it is an essential nutrient, plants likely have a wide range of tolerance to manganese.

A literature search was conducted on the toxicological effects of manganese ingestion to mammals. A study was conducted on the reproductive effects of manganese on rats (Laskey et al. 1982). The rats were fed three dose levels of manganese: 400, 1100, and 3550 ppm. A dose of 3550 ppm caused reduced pregnancy and fertility and was therefore considered a chronic LOAEL. The chronic LOAEL was converted to a daily dose of LOAEL of 284 mg/kg/day (Sample et al. 1996). No effects were observed at lower exposure levels. A chronic NOAEL of 1100 ppm was converted to a daily dose of 88 mg/kg/day (Sample et al. 1996).

A literature search was conducted on the toxicological effects of manganese ingestion to birds. A 75-day study conducted on growth and behavioral effects of manganese on Japanese quail indicated a chronic NOAEL of 977 mg/kg/day (Laskey and Edens 1985) because no reduction in growth was observed but aggressive behavior declined. A chronic LOAEL of 9770 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Laskey, J.W. and F.W. Edens. 1985. Effects of chronic high-level manganese exposure on male behavior in the Japanese quail *(Cotirnix coturnix japonica). Poult. Sci.* 64:579-584.

Laskey, J.W., G.L. Rehnberg, J.F. Hein, and S.D. Carter. 1982. Effects of chronic manganese (Mn_3O_4) exposure on selected reproductive parameters in rats. *J. Toxicol. Environ. Health.* 9:677-687.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Mercury

Mercury is persistent in the environment and may cause significant effects on ecological receptors. A variety of adverse biological effects have been attributed to mercury. Mercury is a known teratogen, mutagen, and carcinogen. Mercury has been documented to adversely effect reproduction, growth and development, behavior, blood and serum chemistry, motor coordination, vision, hearing, histology, and metabolism at relatively low concentrations in birds and mammals. The reproduction, growth, metabolism, blood chemistry, and oxygen exchange of marine and freshwater organisms also is adversely affected by relatively low concentrations of mercury. The form of mercury most readily assimilated by biota is methylmercury. Once incorporated in tissues, methylmercury is very slow to depurate. The rate of bioaccumulation of methylmercury is species- and site-specific.

A three-generation study on the effects of mercury (administered orally as methyl mercury chloride) on the reproduction of rats indicated a LOAEL of 0.16 mg/kg/day because reduced pup viability was observed (Verschuuren et al. 1976). A chronic NOAEL of 0.032 mg/kg/day was determined because no adverse reproductive effects were observed at this level.

A 93-day study conducted on mink indicated that a dose of 1.8 ppm (administered orally as methyl mercury chloride) caused mortality, weight loss, and behavioral abnormalities (Wobeser et al. 1976). No adverse effects were observed at 1.1 ppm so this dose was considered a chronic NOAEL. These values were converted to a daily dose of 0.25 mg/kg/day (chronic LOAEL) and 0.15 mg/kg/day (chronic NOAEL).

A literature search was conducted on the toxicological effects of mercury ingestion to birds. A one-year study conducted on Japanese quail indicated that an oral dose of 0.9 mg/kg/day (as mercuric chloride) caused reduced fertility and egg hatchability (Sample et al. 1996). This dose was considered a chronic LOAEL. No adverse reproductive effects were observed at a dose of 0.45 mg/kg/day. This dose was considered a chronic NOAEL.

Mallards fed methyl mercury during a 3-generation study showed significant reproductive effects (reduced egg and duckling production) at a daily dose 0.064 mg/kg/day (Sample et al. 1996). This dose was considered a chronic LOAEL. A chronic NOAEL of 0.0064 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Verschuuren, R.G., R. Kroes, E.M. Den Tonkelaar, J.M. Berkvens, P.W. Helleman, A.G. Rauws, P.L. Schuller, and G.J. Van Esch. 1976. Toxicity of methyl mercury chloride in rats. II. Reproduction study. *Toxicol.* 6:97-106.

Wobeser, G., N.O. Nielson, and B. Schiefer. 1976. Mercury and mink. II. Experimental methyl mercury intoxication. *Can. J. Comp. Med.* 34-45.

Selenium

Selenium is a metal commonly found in rocks and soil. In the environment, selenium is not often found in the pure form. Much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals. Selenium and oxygen combine to form several compounds. Small selenium particles in the air settle to the ground or are taken out of the air in rain. Soluble selenium compounds in agricultural fields can be transported from the field in irrigation drainage water. Selenium can accumulate in animals that live in water containing high levels of selenium. Very high amounts of selenium can result in reproductive effects in rats and monkeys. Exposure to high levels of selenium compounds caused malformations in birds, but selenium has not been shown to cause birth defects in other mammals (ATSDR 1996). Chronic exposure of mice and rats to selenium adversely affected fertility and reduced the viability of the offspring of the pairs of mice that were able to breed (Schroeder and Mitchener 1971).

A one-year study on the effects of potassium selenate on the reproduction of rats indicated a chronic oral toxic dose of 1.5 mg/L (Rosenfeld and Beath 1954). This dose was considered to be a chronic NOAEL because no adverse effects were observed. This dose was converted to a daily dose of 0.20 mg/kg/day. A chronic LOAEL of 2.5 mg/L was indicated due to a reduction in the number of second-generation young. This dose was converted to a daily dose of 0.33 mg/kg/day.

A 100-day study conducted on the effects of selanomethionine on reproduction in mallard ducks indicated a chronic NOAEL of 4 ppm in food because it produced no adverse effects on reproduction. This dose was converted to a daily dose of 0.4 mg/kg/day (Sample et al. 1996). A dose of 8 ppm was determined to be the chronic LOAEL because it resulted in reduced duckling survival and was converted to a daily dose of 0.8 mg/kg/day.

Reproduction in screech owls fed selanomethionine for 13.7 weeks was not adversely affected at a daily dose of 0.44 mg/kg/day (chronic NOAEL), although a daily dose of 1.5 mg/kg/day (chronic LOAEL) resulted in decreased egg production, egg hatchability, and nestling survival (Sample et al. 1996).

Agency for Toxic Substances and Disease Registry (ATSDR). 1996. *Toxicological profile for selenium.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Rosenfeld, I. and O.A. Beath. 1954. Effect of selenium on reproduction in rats. *Proc. Soc. Exp. Biol. Med.* 87:295-297.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Schroeder, H.A. and M. Mitchener. 1971. Toxic effects of trace elements on the reproduction of mice and rats. *Arch. Environ. Health.* 23:102-106.

Silver

Silver adheres strongly to clay particles found suspended in water and in sediments. The impact of silver is most likely to occur in the soil/water interface. It is acutely toxic to scuds at <6 μg/L and midges at <5 μg/L. Aquatic plants are less sensitive to silver exposure.

A literature search was conducted on the toxicological effects of silver ingestion to mammals and birds. Ingestion-based studies were not available for birds. A study conducted on rats indicated that a dose of 18.1 mg/kg/day did not result in increased mortality. This dose was considered a chronic NOAEL (ASTDR 1990). A chronic LOAEL was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for silver.* TO-90/24.

Thallium

Thallium enters the environment primarily from coal-burning and smelting, in which it is a trace contaminant of the raw materials. Thallium is absorbed by plants and enters the food chain. It builds up in fish and shellfish. Studies in rats exposed to high levels of thallium, showed adverse developmental effects (ATSDR 1992). Rats ingesting thallium for several weeks had some adverse reproductive effects (ATSDR 1992). Data also suggest that the male animal reproductive system may be susceptible to damage by low levels of thallium.

A literature search was conducted on the toxicological effects of thallium ingestion to mammals and birds. Ingestion-based studies were not available for birds. A study conducted on the reproductive (male testicular function) effects of thallium in rats indicated that a dose of 0.74 mg/kg/day caused reduced sperm motility (Formigli et al. 1986). This dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1 to obtain a daily dose 0.074 mg/kg/day.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for thallium.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Formigli, L.,R. Scelsi, P. Poggi, C. Gregotti, A. DiNucci, E. Sabbioni, L. Gottardi, and L. Manzo. 1986. Thallium-induced testicular toxicity in the rat. *Environ. Res.* 40:531-539.

Vanadium

Vanadium enters the environment primarily from natural sources and from the burning of fuel oils. It is an essential element in certain animals, but may induce toxic effects in sufficient quantities. Young rats fed 92 and 194 ppm vanadium lost body weight and exhibited gross pathological symptoms, and 56 percent of those fed 368 ppm vanadium died (Daniel and Lillie 1938). In a study with mallard ducks, vanadium accumulated in the bone, kidney, and liver. Hens fed 100 ppm accumulated vanadium in the bone to about five times the levels in drakes (White and Dieter 1978). Several studies have shown contradictory effects of vanadium on lipid metabolism in birds and mammals. Responses were dependent on species, age, and diet composition. The alterations in lipid metabolism caused by vanadium were considered biologically significant because they were demonstrable in ducks that had absorbed and accumulated only minute tissue concentrations of the metal (White and Dieter 1978).

A literature search was conducted on the toxicological effects of vanadium ingestion to mammals. A 60-day study was conducted on the reproductive effects of vanadium to rats. The rats were fed three dose levels of sodium metavanadate: 5, 10, and 20 mg/kg/day. Significant differences in reproductive parameters (e.g., number of dead young, litter size) were observed at all dose levels. Therefore, the lowest dose was considered to be a chronic LOAEL. The LOAEL of 5 mg/kg/day was converted to an elemental vanadium dosage of 2.1 mg/kg/day (Sample et al. 1996). A chronic NOAEL (0.21 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A literature search was conducted on the toxicological effects of vanadium ingestion to birds. A study conducted on mortality, body weight, and blood chemistry effects of vanadium to mallards indicated a chronic NOAEL of 11.4 mg/kg/day (White and Dieter 1978). The mallards were fed three dose levels of vanadium in food over a 12-week period and no effects were observed at any dose level. The maximum dose was considered the chronic NOAEL. A chronic LOAEL (114 mg/kg/day) was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Daniel, E.P. and R.D. Lillie. 1938. Experimental vanadium poisoning in the white rat. *U.S. Public Health Rep.* 53:765-777.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

White, D.H. and M.P. Dieter. 1978. Effects of dietary vanadium in mallard ducks. *J. Toxicol. Environ. Health.* 4:43-50.

Zinc

Zinc, like many other metals, is essential in cell growth and enzymatic formation. *Ceriodaphnia,* a genus of aquatic invertebrates, are the most sensitive of 35 genera tested, but some aquatic plants are three times as sensitive to zinc. Zinc toxicity can result in destruction of gill epithelium and tissue hypoxia in fish. In terrestrial species, chronic exposure to zinc can result in softening of bone, anemia, enteropathy, and kidney damage. Zinc is not known to magnify in food chains because the body regulates it and excess zinc is eliminated.

A study conducted with rats indicated that a dose of 320 mg/kg/day of zinc caused adverse reproductive effects in pregnant rats (Sample et al. 1996). This dose was considered a chronic LOAEL. A chronic NOAEL of 160 mg/kg/day was determined since no adverse effects were observed at this dose. Mink exposed to zinc in the diet for 25 weeks did not exhibit any adverse reproductive effects at a daily dose of 20.8 mg/kg/day (ATSDR 1992).

Reproduction in chickens exposed to zinc in the diet for 44 weeks was not adversely affected at a daily dose of 14.5 mg/kg/day but was adversely affected at 131 mg/kg/day. These doses are considered chronic NOAEL and LOAEL values, respectively (Sample et al. 1996).

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for zinc.* Draft.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Polychlorinated Biphenyls (PCBs)

Aroclor 1016, 1221, 1232, 1242, 1248, 1254, and 1260

PCBs are a group of manufactured organic chemicals that were banned in the United States in 1977 because of their proven adverse environmental effects. PCBs occur in a variety of different formulations consisting of mixtures of individual compounds such as Aroclor 1016, 1248, 1254, and Aroclor 1260. The Aroclor formulations vary in the percent chlorine, and generally, the higher the chlorine content the greater the toxicity. PCBs elicit a variety of biologic and toxic effects including death, birth defects, reproductive failure, liver damage, tumors, and a wasting syndrome (Eisler 1986). Skin exposure to PCBs in animals resulted in liver, kidney, and skin damage (ATSDR 1996). They are known to bioaccumulate and to biomagnify within the food chain. PCBs in water accumulate in fish and marine mammals and can reach levels thousands of times higher than the levels in water (ATSDR 1996). Toxicity data for white-footed mice, oldfield mice, and mink show that their reproductive systems and developing embryos were adversely affected by both acute and chronic exposures (McCoy et al. 1995).

An 18-month study conducted on the effects of Aroclor 1016 on the reproduction of mink indicated that 25 ppm in the diet reduced kit growth (Aulerich and Ringer 1980). This dose was considered a chronic LOAEL and was converted to a daily dose of 3.43 mg/kg/day. The 10 ppm dose was considered to be a chronic NOAEL because no adverse effects were observed at this dosage. The chronic NOAEL was converted to a daily dose of 1.37 mg/kg/day.

A 7-month study on the effects of Aroclor 1242 on the reproduction of mink indicated that doses of 5, 10, 20, and 40 ppm caused complete reproductive failure (Bleavins et al. 1980). The 5 ppm dose (chronic LOAEL) was converted to a daily dose of 0.69 mg/kg/day. A chronic NOAEL of 6.9 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A study conducted on the effects of Aroclor 1242 on the reproduction on two generations of screech owls indicated that a 3 ppm dose had no observed effects (McLane and Hughes 1980). This dose (chronic NOAEL) was converted to a daily dose of 0.41 mg/kg/day. A chronic LOAEL of 4.1 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

A 5-week study on the effects of Aroclor 1248 on immune function in mice indicated a dose of 13 mg/kg/day to be a chronic LOAEL (ATSDR 1996). A chronic NOAEL of 1.3 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A year-long study conducted on oldfield mice indicated that 5 ppm of Aroclor 1254 in the diet reduced the number of litters, offspring weights, and offspring survival (McCoy et al. 1995). This dose was considered a chronic LOAEL and converted to a daily dose of 0.68 mg/kg/day (Sample et al. 1996). A chronic NOAEL of 0.068 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A study conducted by Aulerich and Ringer (1977) exposed mink to 3 dose levels of Aroclor 1254 for a 4.5-month period. Exposure to 5 and 15 ppm in the diet reduced the number of offspring born alive. A dose of 1 ppm caused no adverse effects. The 5 ppm dose was considered to be a chronic LOAEL and was converted to a daily dose of 0.69 mg/kg/day (Sample et al. 1996). The

1 ppm dose was considered to be a chronic NOAEL and was converted to a daily dose of 0.14 mg/kg/day.

A study conducted on ring-necked pheasants indicated that a dose of 1.8 mg/kg/day in the diet for 17 weeks caused significantly reduced egg hatchability (Dahlgren et al. 1972). This dose was considered a chronic LOAEL. A chronic NOAEL of 0.18 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1996. *Toxicological profile for polychlorinated biphenyls (update)*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Aulerich, R.J. and R.K. Ringer. 1977. Current status of PCB toxicity, including reproduction in mink. *Arch. Environ. Contam. Toxicol.* 6:279-292.

Aulerich, R.J. and R.K. Ringer. 1980. *Toxicity of the polychlorinated biphenyl Aroclor 1016 to mink.* Environmental Research Laboratory, Office of Research and Development.

Bleavins, M.R., R.J. Aulerich, and R.K. Ringer. 1980. Polychlorinated biphenyls (Aroclors 1016 and 1242): Effects on survival and reproduction in mink and ferrets. *Arch. Environ. Contam. Toxicol.* 9:627-635.

Dahlgren, R.B., R.L. Linder, and C.W. Carlson. 1972. Polychlorinated biphenyls: their effects on penned pheasants. *Environ. Health Perspect.* 1:89-101.

Eisler, R. 1986. *Polychlorinated biphenyl hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish and Wildlife Service, Contaminant Hazard Reviews, Report No. 7.

McCoy, G., M.F. Finlay, A. Rhone, K. James, and G.P. Cobb. 1995. Chronic polychlorinated biphenyls exposure on three generations of oldfield mice (*Permyscus polionotus*): effects on reproduction, growth, and body residues. *Arch. Environ. Contam. Toxicol.* 28:431-435.

McLane, M.A.R. and D.L. Hughes. 1980. Reproductive success of screech owls fed Aroclor 1248. *Archives of Environmental Contamination and Toxicology.* 9:661-665.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Pesticides

4, 4'-DDD, 4, 4'-DDE, and 4, 4'-DDT

DDT is a synthetic organochlorine compound which has been used extensively for insect control. DDD and DDE are metabolites of DDT. Both of these two breakdown products and DDT are often found together in the environment and are referred to collectively as total DDT. DDT was banned in the United States in 1972, primarily due to its environmental effects, but is very persistent in the environment and is still detected in many biochemical and geochemical surveys.

The USEPA's Aquatic Information Retrieval Toxicity database (AQUIRE) for DDT contains more than 40 acute toxicity values for various aquatic organisms. These range from 0.36 µg/L for *Daphnia pulex* to 1230 µg/L for the planarian *Polycellis felina* (USEPA 1984).

Historical studies of terrestrial invertebrates have found that earthworms are much more tolerant of organochlorine pesticides than arthropods (Davis 1971). The storage of total DDT in earthworms can lead to harmful effects in higher trophic-level organisms including birds and mammals.

The toxicity and accumulation of DDT in fish are correlated with age, fat content, and body length. Signs of toxicity are similar to those exhibited by insects (Ellgaard et al. 1977). Exposure to lethal concentrations of DDT results in increasing levels of irritability or excitability followed by muscular spasms, complete loss of equilibrium, convulsions, and eventually death. Toxic effects on amphibians and reptiles include uncoordinated behavior, loss of equilibrium, restricted development, weight loss, and death (Russell et al. 1995).

The toxicity and accumulation of DDT and its metabolites are of primary concern in birds. These chemicals can accumulate in fat after even brief, low-level exposures. In general, birds that feed on fish or other birds have greater tissue residues than those that feed on vegetation or seeds, and DDE is more common than either DDT or DDD in bird tissues (Stickel 1973). Adverse effects resulting from DDT poisoning in birds include reproductive impairment, reduced fledging success, and eggshell thinning. DDE produced significant eggshell thinning in three major groups of birds: the orders Strigiformes (owls), Falconiformes (all other raptors), and Anseriformes (most common waterfowl).

Studies of DDT toxicity to mammals have been generally limited to laboratory mammals. Liver, neurological, developmental, reproductive, and carcinogenic effects after exposure to DDT have also been noted for mice, rats, shrews, hamsters, monkeys, dogs, and bats. Laboratory studies with wild mammals have indicated that big brown bats are much more sensitive to DDT than other mammals (Stickel 1973).

A literature search was conducted on the effects of 4, 4'-DDD, 4, 4'-DDE, 4, 4'-DDT ingestion to mammals and birds. A study conducted on the reproductive effects of DDT on rats indicated a chronic NOAEL of 0.8 mg/kg/day and a chronic LOAEL of 4 mg/kg/day (Fitzhugh 1948). The rats ingested three dose levels over a 2-year period. Consumption of 4 mg/kg/day caused a reduction in the number of young produced. No adverse effects were observed at the 0.8 mg/kg/day dose level.

Dogs fed DDT for two generations showed reproductive effects at an oral dose of 5 mg/kg/day but not at 1 mg/kg/day. These values are considered the chronic LOAEL and chronic NOAEL, respectively (ATSDR 1994).

A 2-year reproductive study with American kestrels resulted in estimated chronic NOAEL and LOAEL values of 0.05 and 0.5 mg/kg/day, respectively, for DDE. Chronic oral exposures of mallards with DDT and DDD resulted in chronic NOAEL and LOAEL values (reproductive endpoints) of 0.104 and 1.04 mg/kg/day, respectively, for DDT, and 0.52 and 5.2 mg/kg/day, respectively for DDD (Stickel 1973). Brown pelicans exposed to DDE showed no chronic reproductive effects at 0.131 mg/kg/day (Beyer et al. 1996).

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. *Toxicological profile for 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD*. May.

Beyer, W.N., G.H. Heinz, and A.W. Redmon-Norwood. 1996. *Environmental contaminants in wildlife: interpreting tissue concentrations*. Lewis Publishers, Boca Raton, FL. 494 pp.

Davis, B.N.K. 1971. Laboratory studies on the uptake of dieldrin and DDT by earthworms. *Soil Biol. Biochem.* 3:221-233.

Ellgaard, E.G., J.C. Ochsner, and J.K. Cox. 1977. Locomotor hyperactivity induced in the bluegill sunfish, *Lepomis macrochirus*, by sublethal concentrations of DDT. *Can. J. Zool.* 55:1077-1081.

Fitzhugh, O.G. 1948. Use of DDT insecticides on food products. *Ind. Eng. Chem.* 40:704-705.

McLane, M.A.R. and L.C. Hall. 1972. DDE thins screech owl eggshells. *Bulletin of Environmental Contamination and Toxicology*. 8:65-68.

Russell, R.W., S.J. Hecnar, and G.D. Haffner. 1995. Organochlorine pesticide residues in southern Ontario spring peepers. *Environ. Contam. Toxicol.* 14:815-817.

Stickel, L.F. 1973. Pesticide residues in birds and mammals. Pages 254-312 IN C.A. Edwards (ed). *Environmental pollution by pesticides*. Plenum Press, New York.

United States Environmental Protection Agency (USEPA). 1984. *AQUIRE: Aquatic information retrieval toxicity database*. EPA/600/8-84-021.

Aldrin and Dieldrin

Aldrin and dieldrin are insecticides that do not occur naturally in the environment. From 1950 to 1970, aldrin and dieldrin were popular pesticides for crops like corn and cotton. Because of concerns about damage to the environment and the potential harm to human health, USEPA banned all uses of aldrin and dieldrin in 1974 except to control termites. In 1987, USEPA banned all uses (ATSDR 1993).

Aldrin is easily converted to dieldrin in the environment, and after being ingested and absorbed in animals. Aldrin is found in the blood only after very high doses. Dieldrin binds tightly to soil and slowly evaporates to the air. Dieldrin breaks down very slowly in the environment. Plants uptake and store dieldrin from the soil. In animals, dieldrin accumulates in fatty tissues and leaves the body very slowly. The major acute toxic effects are on the central nervous system. Studies in animals also indicate that dieldrin may reduce the body's ability to resist infection. Mice given high amounts of dieldrin developed liver cancers (ATSDR 1993).

A three-generation study on the effects of dieldrin on rat reproduction indicated that a chronic dose of 2.5 mg/kg (Treon and Cleveland 1955) caused a reduction in the number of pregnancies. This dose was considered a chronic LOAEL and converted to a daily dose of 0.2 mg/kg/day. A chronic NOAEL of 0.02 mg/kg/day was determined by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A 2-year study of the effects of dieldrin on the reproduction of barn owls indicated a chronic NOAEL of 0.077 mg/kg/day (Mendenhall et al. 1983). A slight reduction in the eggshell thickness was observed, but no effects on the number of eggs laid per pair, number of eggs hatched per pair, percent of eggs broken, or embryo and nestling mortality were observed. A LOAEL of 0.77 mg/kg/day was estimated by multiplying the NOAEL by an uncertainty factor of 10.

Rats exposed to aldrin for three generations showed adverse reproductive effects at a daily dose of 1 mg/kg/day, but not at a dose of 0.2 mg/kg/day. These doses are considered the chronic LOAEL and NOAEL, respectively (Sample et al. 1996). Chronic NOAELs and LOAELs for mallards exposed to aldrin in the diet have been estimated at 0.5 and 5 mg/kg/day based on data from Tucker and Crabtree (1970).

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for dieldrin.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Mendenhall, V.M., E.E. Klaas, and M.A.R. McLane. 1983. Breeding success of barn owls (Tyto alba) fed low levels of DDE and dieldrin. *Arch. Environ. Contam. Toxicol.* 12:235-240.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Treon, J.F. and F.P. Cleveland. 1955. Toxicity of certain chlorinated hydrocarbon insecticides for laboratory animals, with special reference to aldrin and dieldrin. *Ag. Food Chem.* 3:402-408.

Tucker, R.K. and D.G. Crabtree. 1970. *Handbook of toxicity of pesticides to wildlife.* U.S. Fish and Wildlife Service Research Publication 84. 131 pp.

Alpha-, Beta-, and Delta-BHC

A literature search was conducted on the toxicological effects alpha-, beta-, and delta-BHC ingestion to animals. A 4-generation rat study with mixed BHC isomers indicated adverse reproductive effects at 3.2 mg/kg/day (chronic LOAEL) but not at 1.6 mg/kg/day (chronic NOAEL; Sample et al. 1996). Rats exposed to beta-BHC for 13 weeks exhibited growth and systemic effects at 20 mg/kg/day (chronic LOAEL) but not 4 mg/kg/day (chronic NOAEL; Sample et al. 1996). Japanese quail exposed to mixed BHC isomers BHC for 90 days exhibited reproductive effects at 2.25 mg/kg/day (chronic LOAEL) but not 0.56 mg/kg/day (chronic NOAEL; Sample et al. 1996).

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Endosulfan I, Endosulfan II, and Endosulfan Sulfate

Endosulfan occurs in two isomeric forms, endosulfan I and endosulfan II. The ratio of these two forms varies depending on the environmental media from which the samples are collected. Air tends to have the highest ratio of endosulfan I to endosulfan II. Air/water partitioning experiments were conducted with the technical mix of endosulfan and with the individual isomers. The partitioning in these experiments resulted in a ratio of endosulfan I to endosulfan II similar to what was observed in the environment. The results of this experiment suggest that endosulfan II is being converted to endosulfan I as it transfers across the air/water interface. This has important implications to modeling the fate of these materials in the environment (ATSDR 1993). Endosulfan sulfate results from the oxidation of endosulfan in nature (Coleman and Dolinger 1982).

A literature search was conducted on the toxicological effects of endosulfan ingestion to mammals and birds. Form-specific information was not available therefore toxicity studies on total endosulfan were used for endosulfan I, endosulfan II, and endosulfan sulfate. A 30-day study conducted on male and female rats indicated that 1.5 mg/kg/day of endosulfan in the diet did not cause adverse reproductive effects (Dikshith et al. 1984). This dose was considered a chronic NOAEL. A chronic LOAEL of 15 mg/kg/d was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

A literature search was conducted on the toxicological effects of endosulfan ingestion to birds. A study conducted by Abiola (1992) on gray partridges indicated that 5, 25, and 125 ppm of endosulfan in the diet did not cause adverse reproductive effects. The maximum dose of 125 ppm (10 mg/kg/d) was considered a chronic NOAEL because exposure occurred during reproduction (Sample et al. 1996). A LOAEL of 100 mg/kg/d was estimated by multiplying the NOAEL by an uncertainty factor of 10.

Abiola, F.A. 1992. Ecotoxicity of organochloride insecticides: effects of endosulfan on birds' reproduction and evaluation of its induction effects in partridge, *Perdix perdix* L. *Rev.Vet. Med.* 143:443-450.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for 1,4-endosulfan.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Coleman, P.F. and P.M. Dolinger. 1982. *Endosulfan monograph number four: environmental health evaluations of California restricted pesticides.* Prepared by Peter M. Dolinger Associates, Menlo Park, CA. Sacramento, CA: State of California Department of Food and Agriculture.

Dikshith, T.S.S., R.B. Raizada, M.K. Srivastava, and B.S. Kaphalia. 1984. Response of rats to repeated oral administration of endosulfan. *Ind. Health.* 22:295-304.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision*. Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Endrin, Endrin Aldehyde, and Endrin Ketone

Endrin was used in the United States as a pesticide and rodenticide but the use of endrin was banned in 1984. Endrin does not easily dissolve in water and is more likely to be found in sediments. Endrin breaks down slowly in the environment (ATSDR 1989). Endrin can bioaccumulate in aquatic animals from 1450 to 10000 times the concentration in water (USEPA 1980).

Little information is known about the properties of endrin aldehyde. It is not commercially used but is found as an impurity and breakdown product of endrin. It is not known what happens to this substance once it is released to the environment (ATSDR 1989). Endrin ketone might be found in the environment as a breakdown product of endrin. Little information is known about the properties of endrin ketone (ATSDR 1996).

A dietary dose of 0.92 mg/kg/day of endrin over 120 days caused significant reproductive effects in mice including reduced parental survival, litter size, and number of young (Good and Ware 1969). This dose was considered a chronic LOAEL. A chronic NOAEL of 0.092 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

A study conducted by Fleming et al. (1982) exposed screech owls to a dietary dose of 0.75 ppm (0.1 mg/kg/day) of endrin over 10 weeks to assess reproductive effects. Egg production and hatching success was reduced. This dose was considered a chronic LOAEL. A chronic NOAEL of 0.01 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Mallards exposed to endrin in the diet for 200+ days showed no adverse reproductive effects at 0.3 mg/kg/day (the highest dose tested). This dose is considered a chronic NOAEL (Sample et al. 1996). A chronic LOAEL was estimated by multiplying the chronic NOAEL by and uncertainty factor of 10.

Agency for Toxic Substances and Disease Registry (ATSDR). 1996. *Endrin ketone*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for endrin/endrin aldehyde*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Fleming, W.J., M.A. Ross McLane, and E. Cromartie. 1982. Endrin decreases screech owl productivity. *J. Wildl. Manage.* 46:462-468.

Good, E.E. and G.W. Ware. 1969. Effects of insecticides on reproduction in the laboratory mouse. IV. Endrin and dieldrin. *Toxicol. Appl. Pharmacol.* 14:201-203.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision*. Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

United States Environmental Protection Agency (USEPA). 1980. *Ambient water quality criteria for endrin.* Washington, D.C. Office of Water Regulations and Standards. EPA-440/5-80-047. NTIS No. PB81-117582.

Heptachlor and Heptachlor Epoxide

Heptachlor is a manufactured chemical that does not occur naturally. Heptachlor does not dissolve easily in water, adheres strongly to soil particles, and evaporates slowly to air. Plants and animals can change heptachlor ($C_{10}H_5Cl_7$) to heptachlor epoxide ($C_{10}H_5Cl_7O$) by means of oxidation. Heptachlor epoxide can remain in the soil and water for many years. Plants can uptake heptachlor from the soil. Heptachlor and heptachlor epoxide have been shown to bioaccumulate in the tissues of fish, bivalves, and cattle (ATSDR 1993).

Most of what we know about the health effects of these pesticides comes from studies on mice and rats fed heptachlor and heptachlor epoxide. Acute studies using high levels of heptachlor damaged the livers of rats and the livers and adrenal glands of mice. Mice also had trouble walking and rats developed tremors. Animals that ingested heptachlor or heptachlor epoxide before and/or during pregnancy had smaller litters or were unable to reproduce. Some of the offspring had cataracts and others died shortly after birth (ATSDR 1993).

A literature search was conducted on the toxicological effects of heptachlor ingestion to mammals and birds. An 181-day study on the effects of heptachlor on the reproduction of mink indicated a chronic LOAEL of 6.25 ppm (Crum et al. 1993) which was converted to a daily dose of 1.0 mg/kg/day. Minks given this dose were observed to have reduced kit weights at 3 and 6 weeks as compared to controls. A chronic NOAEL of 0.1 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Studies with quail (Hill et al. 1975) result in estimated chronic NOAELs and LOAELs of 0.405 and 4.05 mg/kg/day, respectively.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for heptachlor.* .S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Crum, J.A., S.J. Bursian, R.J. Aulerich, P.Polin, and W.E. Braselton. 1993. The reproductive effects of dietary heptachlor in mink (*Mustela vison*). *Arch. Environ. Contam. Toxicol.* 24:156-164.

Hill, E.F., R.G. Heath, J.W. Spann, and J.D. Williams. 1975. *Lethal dietary toxicities of environmental pollutants to birds.* U.S. Fish and Wildlife Service Special Scientific Report - Wildlife No. 191, Washington D.C.

Methoxychlor

Methoxychlor is a man made insecticide used to kill flies, cockroaches and mosquitoes. Methoxychlor is released to the environment from chemical plants that produce it and from hazardous waste sites. Methoxychlor remains in the atmosphere for under a month. Methoxychlor does not dissolve in water but instead binds to sediments where it is degraded. It bioaccumulates in some aquatic species but not in mammalian species due to high metabolism and elimination.

Methoxychlor is a structural analogue of the pesticide DDT. Renal nephrosis was observed in rats administered methoxychlor in their diets. In pigs fed methoxychlor, cytic tubular nephropathy and elevated blood urea nitrogen was observed (ATSDR 1992).

In an 11-month study on the effects of methoxychlor on the reproduction of rats, no significant effects were observed at doses of 50 ppm (Gray et al. 1988). This exposure level was considered to be a chronic NOAEL and was converted to a daily dose of 4 mg/kg/day. A dose of 100 ppm caused significant reduction in the fertility and litter size of the rats. This dose (8 mg/kg/day) was considered a chronic LOAEL. Mortality studies with quail indicate estimated chronic LOAEL and NOAEL values of 4050 and 405 mg/kg/day, respectively (Hill and Camardese 1986).

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for methoxychlor*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Gray L.E., J.S. Ostby, and J.M. Ferrell. 1988. Methoxychlor induces estrogen-like alterations of behavior and the reproductive tract in the female rat and hamster: Effects on sex behavior, running wheel activity, and uterine morphology. *Toxicol. Appl. Pharmacol.* 96:525-540.

Hill, E.F. and M.B. Camardese. 1986. *Lethal dietary toxicities of environmental contaminants and pesticides to Coturnix*. U.S. Fish and Wildlife Service Technical Report 2.

Toxaphene

Toxaphene is a pesticide used to control insects on crops such as cotton, on livestock, and to control unwanted fish species in lakes. Most uses of toxaphene were banned in 1982 due to its effects on the health of both humans and animals. Toxaphene is a mixture of over 160 chemicals. In soil, toxaphene will vaporize or will adhere to soil particles. In surface water, it vaporizes or settles to the sediment, but does not dissolve easily in the water. Toxaphene can be transported in the air without change for long distances from the site of release due to its resistance to abiotic transformation (ATSDR 1990).

Toxaphene bioaccumulates in aquatic animals at levels of 10^4 and biomagnifies in aquatic food chains. Under anaerobic conditions, toxaphene has a half-life of approximately weeks or months, but in aerobic condiríons, it has a half-life of years (ATSDR 1990).

A study over three generations of rats on the effects of toxaphene on reproduction reported no adverse effects at dose levels of 25 and 100 ppm of toxaphene (Kennedy et al. 1973). The 100 ppm dose was considered a chronic NOAEL (8 mg/kg/day). A chronic LOAEL of 80 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. Mortality studies with mallards indicate estimated chronic LOAEL and NOAEL values of 3.07 and 0.307 mg/kg/day, respectively (Hill and Camardese 1986).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for toxaphene*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Hill, E.F. and M.B. Camardese. 1986. *Lethal dietary toxicities of environmental contaminants and pesticides to Coturnix*. U.S. Fish and Wildlife Service Technical Report 2.

Kennedy, G.G. Jr., M.P. Frawley, and J.C. Calandra. 1973. Multigeneration reproductive effects of three pesticides in rats. *Toxicol. Appl. Pharmacol.* 25:589-596.

Semivolatile Organics

1,2-Dichlorobenzene and 1,3-Dichlorobenzene

Chronic rat studies with 1,2-dichlorobenzene indicate adverse effects on the liver and kidney at oral doses of 857 mg/kg/day (Coulston and Kolbye 1994). This dose is considered a chronic LOAEL. A chronic NOAEL of 85.7 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Avian data for 1,4-dichlorobenzene is applied to these two chemicals.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. *Regulatory Toxicology and Pharmacology.* 20:S1-S1056.

1,2,3-Trichlorobenzene

Information regarding 1,2,3-Trichlorobenzene was not available in the literature.

1,2,4-Trichlorobenzene

Three-generation rat studies with 1,2,4-trichlorobenzene indicate adverse effects on reproduction at oral doses of 106 mg/kg/day (Coulston and Kolbye 1994). This dose is considered a chronic LOAEL. No adverse reproductive effects were found at a dose of 53 mg/kg/day. This dose is considered the chronic NOAEL. No avian toxicological data were found for this chemical.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. *Regulatory Toxicology and Pharmacology.* 20:S1-S1056.

1,4-Dichlorobenzene

1,4-dichlorobenzene is used mainly as a fumigant for the control of moths, molds, and mildews and as a space deodorant for toilets and refuse containers (ATSDR 1993). Tests involving acute exposure of animals, such as the LD_{50} test in rats and mice, have shown that 1,4-dichlorobenzene has moderate toxicity from oral exposure (RTECS 1993). Studies have reported effects on the blood, liver, and kidneys from acute, oral exposure. Chronic inhalation exposures can cause adverse effects on the respiratory system, liver, and kidneys. A study on pregnant rats reported adverse developmental effects in fetuses when administering the chemical by gavage (HSDB 1993).

An oral study on the effects of 1,4-dichlorobenzene on pregnant rats determined a NOAEL of 250 mg/kg/day (Coulston and Kolbye 1994). At this level, no adverse effects were seen for maternal and developmental toxicity. Effects were observed at 500 mg/kg/day (the chronic LOAEL).

Fourteen-day studies with northern bobwhites showed adverse effect on growth and survival from oral exposures of 2500 mg/kg/day (Grimes and Jaber 1989). A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for 1,4-dichlorobenzene*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. *Regulatory Toxicology and Pharmacology*. 20:S1-S1056.

Grimes, J. and M. Jaber. 1989. *Para-dichlorobenzene: An acute oral toxicity study with the bobwhite, Final Report*. Prepared by Wildlife International Ltd. - Easton, MD under project No. 264-101 and submitted to Chemical Manufacturers Association, Washington, DC, report dated July 19, 1989.

Hazardous Substances Databank (HSDB). 1987. Record for 1,4-Dichlorobenzene. Computer Printout. National Library of Medicine.

Registry of Toxic Effects of Chemical Substances (RTECS). 1993. Online database. U.S. Department of Health and Human Services. National Toxicology Information Program, National Library of Medicine. Bethesda, MD.

2-Chloronaphthalene

Information regarding 2-chloronaphthalene was not available in the literature.

2-Chlorophenol

Information regarding 2-chlorophenol was not available in the literature.

2-Methylnaphthalene

Mice exposed to 2-methylnaphthalene in the diet for 81 weeks showed systemic effects at a dose of 1437 mg/kg/day (the chronic LOAEL; ATSDR 1995). A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Information on the toxicity of 2-methylnaphthalene on birds was not available in the literature.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs)*. August.

2-Methylphenol and 4-Methylphenol

2-methylphenol and 4-methylphenol are also known as cresols. Cresols are manufactured and also occur naturally. These forms occur separately or as a mixture. 2-methylphenol is used to dissolve other chemicals, as a disinfectant and deodorizer, and to produce pesticides. It is found in many foods and in wood and tobacco smoke, crude oil, coal tar, and in brown mixtures such as creosote and cresylic acids, which are wood preservatives. Microorganisms in soil and water produce cresols when they break down materials in the environment (ATSDR 1992).

2-methylphenol occurs widely in the environment at low levels, because it quickly breaks down. It does not evaporate quickly from water, but can be removed by bacteria. In soils, half the total amount of 2-methylphenol will break down in about a week. It does not appear to accumulate in fish or animal tissue (ATSDR 1992).

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for cresols*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

2-Nitroaniline

Information regarding 2-nitroaniline was not available in the literature.

2-Nitrophenol

Information regarding 2-nitrophenol was not available in the literature.

2,2'-Oxybis(1-Chloropropane)

Information regarding 2,2'-oxybis(1-chloropropane) was not available in the literature.

2,4-Dichlorophenol

2,4-Dichlorophenol is a white solid with a medicinal smell that is used to kill germs and to make other chemicals that are used to kill weeds and other plants. In air, 2,4-dichlorophenol degrades to other chemicals within a few days or weeks. 2,4-Dichlorophenol is not expected to bioconcentrate in plants or animals or to biomagnify in food chains (ATSDR 1991).

In a 103-week study on the effects of 2,4-dichlorophenol on reproduction in rats, no adverse effects were observed at concentrations of 440 mg/kg/day in the diet (NTP 1989). This doss was considered to be a chronic NOAEL. A chronic LOAEL of 4400 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991. *Toxicological profile for 2,4-dichlorophenol.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

NTP (National Toxicology Program). 1989. *Toxicology and carcinogenesis studies of 2,4-dichlorophenol in F344/N rats and B6C3F1 mice (feed studies).* Technical Report Series No. 353. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health.

2,4-Dimethylphenol

2,4-dimethylphenol may enter the environment from industrial and municipal discharges or spills. Acute toxic effects may include the death of animals, birds, or fish, and death or low growth rate in plants. 2,4-dimethylphenol has moderate acute toxicity to aquatic life. Insufficient data are available to evaluate or predict the short-term effects of 2,4-dimethylphenol to plants, birds, or land animals. Chronic toxic effects may include shortened life span, reproductive problems, lower fertility, and changes in appearance or behavior. 2,4-dimethylphenol has moderate chronic toxicity to aquatic life (ATDSR 1993).

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for 2,4-dimethylphenol.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

2,4-Dinitrophenol

Dinitrophenols are a class of manmade chemicals of which 2,4-dinitrophenol is the most commercially important. 2,4-dinitrophenol is used for making dyes, wood preservatives, and other organic chemicals. 2,4-dinitrophenol is a yellow solid that dissolves slightly in water. It does not evaporate easily into air but instead settles to the ground in rain and snow. When it enters water it adheres to particles and accumulates in the sediment. It does not bioaccumulate in fish.

2,4-Dinitrotoluene and 2,6-Dinitrotoluene

2,4-dinitrotoluene and 2,6-dinitrotoluene are two of the six forms of dinitrotoluene. They are usually formed by mixing toluene with nitric acid. Dinitrotoluene is used in the production of foams for use in furniture, and in the productions of dyes and munitions. Dinitrotoluene is decomposed by sunlight and by bacteria and therefore does not persist in the environment. It can be transported by surface and groundwater due to its moderate water solubility. Bioaccumulation of 2,4-dinitrotoluene and 2,6-dinitrotoluene in animal tissues is not expected. Plants have been shown to readily uptake 2,4-dinitrotoluene and 2,6-dinitrotoluene.

2,4,5-Trichlorophenol and 2,4,6-Trichlorophenol

Rats exposed to 2,4,5-trichlorophenol for 98 days in the diet demonstrated adverse effects to the hepatic and renal systems at doses of 800 mg/kg/day (McCollister et al. 1961). This dose is considered a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Information regarding toxicological effects on avian species from exposure to 2,4,5-trichlorophenol and 2,4,6-trichlorophenol was not available in the literature.

McCollister, D.D., P.T. Lockwood, and V.K. Rowe. 1961. Toxicologic information on 2,4,5-trichlorophenol. *Toxicology and Applied Pharmacology*. 3:63-70.

3-Nitroaniline

Information regarding 3-nitroaniline was not available in the literature.

3,3'-Dichlorobenzidine

3,3′-dichlorobenzidine breaks down rapidly in water exposed to natural sunlight and in air, but is retained in soil for months. In air, it is estimated that half of the 3,3′-dichlorobenzidine can breakdown within 2 hours. In water exposed to natural sunlight, 3,3′-dichlorobenzidine is expected to break down rapidly with half being removed in approximately 90 seconds.

Death has occurred in experimental animals that have ingested high concentrations of 3,3′-dichlorobenzidine. In studies conducted on pregnant mice, exposure to 3,3′-dichlorobenzidine caused the kidneys of their offspring to develop improperly. Chronic dietary exposure of experimental animals to moderate levels of 3,3′-dichlorobenzidine caused mild injury to the liver (ATSDR 1989).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for 3,3′-dichlorobenzidine*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

4-Bromophenyl-phenylether

Information regarding 4-bromophenyl-phenylether was not available in the literature.

4-Chloro-3-methylphenol

Information regarding 4-chloro-3-methylphenol was not available in the literature.

4-Chloroaniline

Information regarding 4-chloroaniline was not available in the literature.

4-Chlorophenyl-phenylether

Information regarding 4-chlorophenyl-phenylether was not available in the literature.

4-Nitroaniline

Information regarding 4-nitroaniline was not available in the literature.

4-Nitrophenol

Information regarding 4-nitrophenol was not available in the literature.

4,6-Dinitro-2-methylphenol

Information regarding 4,6-dinitro-2-methylphenol was not available in the literature.

Bis(2-chloroethyl)ether

Bis(2-chloroethyl)ether is a manmade colorless non-flammable liquid used in the production of pesticides and other chemicals. Bis(2-chloroethyl)ether is broken down in the air by chemical reactions and in soil and water by bacteria, so it does not persist for long. Studies in animals show that bis(2-chloroethyl)ether can cause severe damage to lungs and can cause death. Studies in mice that ingested bis(2-chloroethyl)ether showed evidence of liver tumors.

Bis(2-chloroethoxy)methane

Information regarding bis(2-chloroethoxy)methane was not available in the literature.

Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate (DEHP) is used in the production of polyvinyl chloride, where it is added to plastics to make them flexible. Acute animal tests, such as the LD_{50} test in rats, have shown DEHP to have low acute toxicity from oral exposure (RTECS 1993). Oral exposure animal studies indicate that DEHP has adverse effects on the liver, kidney, weight gain and food consumption, and can cause liver tumors in rats and mice. Tests on rats and mice demonstrated that DEHP can cause developmental and reproductive toxicity, such as birth defects, decrease in testicular weights, and tubular atrophy (ATSDR 1993). Animal chronic, inhalation exposure studies have reported increased lung weights and liver weights (ATSDR 1993).

A literature search was conducted on the effects of bis(2-ethylhexyl)phthalate ingestion to mammals and birds. A 105-day study conducted on mice indicated that 1000 mg/kg of bis(2-ethylhexyl)phthalate in the diet caused significant reproductive effects (Lamb et al. 1987). The 1000 mg/kg dose was considered the chronic LOAEL. No adverse effects were observed among the 100 mg/kg dose group; this value was considered the chronic NOAEL. These dietary concentrations were converted to a daily doses of 183.3 mg/kg/day (LOAEL) and 18.3 mg/kg/day (NOAEL; Sample et al. 1996).

A 4-week study conducted on the reproductive effects of bis(2-ethylhexyl)phthalate to ringed doves indicated a chronic NOAEL of 10 ppm (Peakall 1974). No significant reproductive effects were observed among doves on diets containing 10 ppm of bis(2-ethylhexyl)phthalate. This dietary concentration was converted to daily dose (NOAEL) of 1.1 mg/kg/day (Sample et al. 1996). A chronic LOAEL was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for bis(2-ethylhexyl)phthalate*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Lamb, J.C., IV, R.E. Chapin, J. Teaque, A.D. Lawton, and J.R. Real. 1987. Reproductive effects of four phthalic acid esters in a mouse. *Toxicol. Appl. Pharmacol.* 88:255-269.

Peakall, D.B. 1974. Effects of di-n-butylphthalate and di-2-ethylhexylphthalate on the eggs of ring doves. *Bull. Environ. Contam. Toxicol.* 12:698-702.

Registry of Toxic Effects of Chemical Substances (RTECS). 1993. Online database. U.S. Department of Health and Human Services. National Toxicology Information Program, National Library of Medicine. Bethesda, MD.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Butylbenzylphthalate

Butylbenzylphthalate is used as a plasticizer. When it is released into the environment, butylbenzylphthalate tends to bind to soil and sediment. It does not persist in the environment when oxygen is present, with half-lives in air, water, and soil of only a few days. It is more persistent at low temperatures, and in an anaerobic environment.

A 2-year study with rats indicated hepatic effects when this chemical was administered orally at a dose of 2400 mg/kg/day (NTP 1997). This value is considered the chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No toxicological data were found for birds.

NTP (National Toxicology Program). 1997. *Effect of dietary restriction on toxicology and carcinogenesis studies of butyl benzyl phthalate (CAS No. 85-68-7) in F344/N rats and B6C3F1 mice (feed studies).* Technical Report Series No. 458, NTP TR458. Prepared by U.S. Department of Health and Human Services.

Di-n-butylphthalate

Di-n-butylphthalate is a man-made chemical that is used to make soft plastics, carpet backing, paints, glue, insect repellents, hairspray, nail polish, and rocket fuel. Di-n-butylphthalate does not evaporate easily, but small amounts do enter into the air as a gas and by attaching to dust particles. In the air, di-n-butylphthalate usually breaks down within a few days. Di-n-butylphthalate does not dissolve easily in water, but can be transported to water by adhering to soil/sediment particles. Bacteria break down di-n-butylphthalate in water and soil within a day or up to a month. The length of time it takes to break down di-n-butylphthalate in soil or water depends on the kind of bacteria present and the soil/water temperature (ATSDR 1990). Di-n-butylphthalate appears to have relatively low toxicity. The levels of di-n-butylphthalate which cause toxic effects in animals are about 10,000 times higher than the typical levels of di-n-butylphthalate found in air, food, or water (ATSDR 1990).

In animals, ingestion of high levels of di-n-butylphthalate can affect their ability to reproduce, cause death of unborn animals, and decrease sperm production. Sperm production seems to return to near normal levels when exposure to di-n-butylphthalate ceases.

A literature search was conducted on the toxicological effects of di-n-butylphthalate ingestion to mammals and birds. In a 105-day study on the effects of di-n-butylphthalate on reproduction of mice, reduced litters per pair and reduced live pups per pair were observed among mice who were fed a diet containing 1 percent di-n-butyl-phthalate (Lamb et al. 1987). This equates to a daily dose of 1833 mg/kg/day (chronic LOAEL). No adverse effects were observed among mice fed diets containing 0.03 or 0.3 percent d-n-butylphthalate. The 0.3 percent dose (550 mg/kg/day) was considered the chronic NOAEL.

A study on the effects of di-n-butylphthalate on the reproduction of ringed doves was conducted over a 4-week period (Peakall 1974). Doves fed diets containing 10 ppm di-n-butylphthalate (1.1 mg/kg/day) were observed to have reduced eggshell thickness and water permeability of the shell. This dose was considered a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for di-n-butylphthalate*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Lamb, J.C., IV, R.E. Chapin, J. Teaque, A.D. Lawton, and J.R. Real. 1987. Reproductive effects of four phthalic acid esters in a mouse. *Toxicol. Appl. Pharmacol.* 88:255-269.

Peakall, D.B. 1974. Effects of di-n-butylphthalate and di-2-ethylhexylphthalate on the eggs of ring doves. *Bull. Environ. Contam. Toxicol.* 12: 698-702.

Di-n-octylphthalate

Small amounts of di-n-octylphthalate can accumulate in animals that live in water, such as fish and oysters. Some rats and mice that were given very high doses of di-n-octylphthalate orally died. Mildly harmful effects have been seen in the livers of some rats and mice given very high doses of di-n-octylphthalate orally for short (14 days or less) or intermediate periods (15 to 365 days) of time, but lower doses given for short periods of time generally caused no harmful effects.

Acute toxic effects may include the death of animals, birds, or fish, and death or low growth rate in plants. Acute effects are seen 2 to 4 days after animals or plants come in contact with the chemical. Di-n-octylphthalate has moderate acute toxicity to aquatic life. Insufficient data are available to evaluate or predict the short- term effects of di-n-octylphthalate to plants, birds, or land animals. Chronic toxic effects may include shortened life span, reproductive problems, lower fertility, and changes in appearance or behavior. Chronic effects can be seen long after first exposure(s). Di-n-octylhthalate has moderate chronic toxicity to aquatic life. Insufficient data are available to evaluate or predict the long- term effects of di-n-octylphthalate to plants, birds, or land animals.

Estimated chronic LOAELs and NOAELs for mice exposed to di-n-hexylphthalate orally for 105 days were 550 and 55 mg/kg/day, respectively (Sample et al. 1996). These values are directly extrapolated to di-n-octylphthalate. Estimated chronic LOAELs and NOAELs for ring-necked pheasant are 500 and 50 mg/kg/day, respectively (TERRETOX 1998).

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Terrestrial Toxicity Database (TERRETOX). 1998. Environmental Research Laboratory, U.S. Environmental Protection Agency, Duluth, MN.

Dibenzofuran

Dibenzofuran is a polynuclear aromatic compound that may be found in coke dust, grate ash, fly ash, and flame soot. It has been listed as a pollutant of concern to USEPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to the environment.

A literature search was conducted on the toxicological effects of dibenzofuran ingestion to mammals and birds. Studies measuring the toxicological effects of dietary dibenzofuran were not available.

Diethylphthalate

Diethylphthalate is a synthetic substance that is commonly used to make plastics more flexible. Products in which it is found include toothbrushes, automobile parts, tools, toys, and food packaging. Diethylphthalate can be released fairly easily from these products because it is not part of the chain of chemicals (polymers) that makes up the plastic. Diethylphthalate is also used in cosmetics, insecticides, and aspirin. Diethylphthalate has a moderate acute and chronic toxicity to aquatic organisms and can be mildly irritating when applied to the skin or eyes of animals.

A literature search was conducted on the toxicological effects of diethylphthalate ingestion to mammals and birds. Information was not available for birds. A 105-day study was conducted on the effects of diethylphthalate on reproduction of mice. Mice fed diets containing 2500, 12,500, and 25,000 mg/kg diethylphthalate did not exhibit any negative reproductive effects (Lamb et al. 1987). The dose of 25,000 mg/kg (chronic NOAEL) was converted to a daily dose of 4,583 mg/kg/day. A chronic LOAEL of 45,830 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

Lamb, J.C., IV, R.E. Chapin, J. Teaque, A.D. Lawton, and J.R. Real. 1987. Reproductive effects of four phthalic acid esters in a mouse. *Toxicol. Appl. Pharmacol.* 88:255-269.

Dimethylphthalate

Dimethylphthalate is a colorless oily liquid with a slightly sweet odor that is used in solid rocket propellants, lacquers, plastics, safety glasses, rubber coating agents, molding powders, insect repellants, and pesticides. In animal studies, acute exposure to dimethylphthalate via inhalation results in irritation of the eyes, nose, and throat. The LD_{50} test in rats has shown dimethylphthalate to have moderate acute toxicity from oral and dermal exposures. Animal studies have reported slight effects on growth and on the kidney from chronic oral exposure to dimethylphthalate.

Hexachlorobenzene

Rats exposed orally to hexachlorobenzene for 2 years demonstrated adverse effects to their reproduction at a dose of 16 mg/kg/day (ATSDR 1989). This dose was considered a chronic LOAEL. A chronic NOAEL (1.6 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Reproductive effects in birds from oral exposures occurred at a dose of 0.8 mg/kg/day (Coulston and Kolbye 1994). This dose was considered a chronic LOAEL. A chronic NOAEL (0.08 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for hexachlorobenzene*. Draft.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. *Regulatory Toxicology and Pharmacology*. 20:S1-S1056.

Hexachlorobutadiene

Hexachlorobutadiene is a colorless, manmade liquid that is used in the production of rubber compounds, and lubricants. Hexachlorobutadiene in the water can be released to soil and air. It is expected to remain there for a long time because it attaches to organic matter in the soil. Hexachlorobutadiene can accumulate in fish and shellfish that live in contaminated waters, but it is not known if hexachlorobutadiene accumulates in plants. Under aerobic conditions in water, hexachlorobutadiene undergoes degradation. Degradation does not occur under anaerobic conditions.

Rats exposed orally to hexachlorobutadiene for 90 days demonstrated adverse effects to their reproduction at a dose of 20 mg/kg/day (IPCS 1994). This dose was considered a chronic LOAEL. A chronic NOAEL (2 mg/kg/day) was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. Reproductive effects in Japanese quail from oral exposures occurred at a dose of 8 mg/kg/day (Coulston and Kolbye 1994). This dose was considered a chronic LOAEL. The chronic NOAEL from this study was 2.5 mg/kg/day.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. *Regulatory Toxicology and Pharmacology*. 20:S1-S1056.

International Programme on Chemical Safety (IPCS). 1994. *Environmental health criteria 156 - hexachlorobutadiene*. World Health Organization, Geneva.

Hexachlorocyclopentadiene

Rats exposed to hexachlorocyclopentadiene during pregnancy demonstrated adverse effects at a dose of 30 mg/kg/day but no adverse effects at 10 mg/kg/day (USEPA 1984). These doses were considered the chronic LOAEL and NOAEL, respectively. Information regarding the toxicological effects on avian species from exposure to hexachlorocyclopentadiene was not available in the literature.

U.S. Environmental Protection Agency (USEPA). 1984. *Health assessment document for hexachlorocyclopentadiene*. EPA/600/8-84/001F.

Hexachloroethane

Information regarding hexachloroethane was not available in the literature.

Isophorone

Isophorone is a man-made chemical for use commercially, but it has been found to occur naturally in cranberries. It is a clear liquid with a peppermint-like odor. It is used as a solvent in some printing inks, paints, lacquers, and adhesives. It evaporates faster than water and it does not mix completely with water. Isophorone does not remain in the air very long, but can remain in water for possibly more than 20 days. The length of time that isophorone will remain in soil is not known, but it is most likely the same as the length of time it remains in water (ATSDR 1989).

Acute exposure of animals to high vapor amounts and chronic exposure of animals to high doses through ingestion caused death, a shortened life span, inactivity, and coma. Inconclusive studies suggest that isophorone may have caused birth defects and growth retardation in the offspring of rats and mice that breathed vapors during pregnancy. Some harmful health effects were observed in adult female animals in these studies. In a long-term study in which rats and mice were given high doses of isophorone orally, the male rats developed kidney disease and kidney tumors. Male rats also developed tumors in a reproductive gland. Some male mice developed tumors in the liver, in connective tissue, and in lymph glands (tissues of the body that help fight disease), but the evidence was not conclusive (ATSDR 1989).

Evidence of carcinogenicity is limited to one sex of one animal species as shown by an increased incidence of preputial gland tumors in male rats; an apparent increase in hepatocellular and integumentary tumors in male mice was complicated by high mortality. No increases were seen in females of either species (USEPA 1988).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for isophorone*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

United States Environmental Protection Agency (USEPA). 1988. Integrated Risk Information System (IRIS). Reference Dose (RfD) for oral exposure of isophorone. Online. (Revised; verification date 5/15/86). Office of Health and Environmental Assessment. Environmental Criteria and Assessment Office, Cincinnati, OH.

N-Nitrosodiphenylamine

N-nitrosodiphenylamine is an industrial compound that has been produced since 1945 in the manufacture of rubber products and other chemicals. Manufacturers have since replaced it with more efficient chemicals. It is not known whether it exists naturally in the environment; there is some evidence that microorganisms may produce it. Aquatic organisms can accumulate low levels of n-nitrosodiphenylamine in their bodies (ATSDR 1993). It is not known whether terrestrial animals and plants accumulate n-nitrosodiphenylamine. Animals exposed to n-nitrosodiphenylamine through long-term dietary intake developed swelling, cancer of the bladder, and changes in body weight (ATSDR 1993). Higher levels have caused death.

Systemic effects in rats fed n-nitrosodiphenylamine for 8 to 11 weeks were observed at a dose of 1500 mg/kg/day (ATSDR 1993). This dose was considered a chronic LOAEL. A chronic NOAEL of 150 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No avian toxicological data were found.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for n-nitrosodiphenylamine.*

N-Nitrosodi-n-propylamine

N-Nitrosodi-n-propylamine is a manmade, yellow liquid produced in small quantities for research. Some n-nitrosodi-n-propylamine is produced as an impurity of some weed killers and during the production of some rubbers. In sunlight (in air or water), n-nitrosodi-n-propylamine degrades within a day by photolysis. In the absence of sunlight, n-nitrosodi-n-propylamine has a half-life of 14 to 80 days in soil (ATSDR 1989). N-Nitrosodi-n-propylamine has been shown to cause cancer of the liver, esophagus, and nasal cavities in mice.

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for n-nitrosodi-n-propylamine.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Nitrobenzene

Nitrobenzene is an oily yellow liquid with an almond-like odor that is produced in large quantities for industrial use. In studies conducted on rats, a single dose of nitrobenzene fed to males resulted in damage to the testicles and decreased levels of sperm. Increased levels of blood methemoglobin have been reported in rats exposed to nitrobenzene at levels as low as 10 ppm per week (Medinsky and Irons 1985) or 5 ppm for 90 days (Hamm et al. 1984). Other studies on rats have reported liver lesions and the degeneration or death of liver cells in male rats exposed to nitrobenzene at 35 ppm for 2 weeks (Medinsky and Irons 1985). Male mice exposed to nitrobenzene at 16 ppm for 90 days suffered increased liver weight, hepatocyte hyperplasi, and multinucleated hepatcytes (Hamm et al. 1984).

There is very little information available about the effects of long-term exposure of animals to nitrobenzene, and it is not known whether exposure to nitrobenzene can cause cancer (ATSDR 1990).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for nitrobenzene.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Hamm, T.E. Jr., M. Phelps, and T.H. Raynor. 1984. A 90-day inhalation study of nitrobenzene in F-344 rats, CD rats and B6C3F1 mice [Abstract]. *Toxicologist.* 4:181.

Medinsky, M.A. and R.D. Irons. 1985. Sex, strain, and species differences in the response of rodents to nitrobenzene vapors. Pages 35-51 IN Rickert D.E. (ed). Chemical Industry Institute of Toxicology Series. *Toxicity of nitroaromatic compounds.* New York, NY: Hemisphere Publishing Corporation.

Pentachlorophenol

Pentachlorophenol is a manufactured chemical not found naturally in the environment. Pentachlorophenol has been used as a biocide and wood preservative. It was one of the most heavily used pesticides in the United States. Now, only certified applicators can purchase and use pentachlorophenol (ATSDR 1992).

Pentachlorophenol adsorbs to soil particles, but is more likely to occur under acidic conditions than neutral or basic conditions. Microorganisms break it down into other compounds in soil and surface waters (ATSDR 1992).

Reproductive effects of pentachlorophenol on rats exposed to pentachlorphenol in the diet for up to 24 months occurred at a dose of 30 mg/kg/day while a dose of 3 mg/kg/day caused no adverse reproductive effects (Coulston and Kolbye 1994). These doses were considered chronic LOAELs and NOAELs, respectively. Chickens fed pentachlorophenol for 8 weeks showed adverse effects on growth at a dose of 200 mg/kg/day but not at 100 mg/kg/day (Eisler 1989). These doses are considered chronic LOAELs and NOAELs, respectively.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for pentachlorophenol.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. *Regulatory Toxicology and Pharmacology.* 20:S1-S1056.

Eisler, R. 1989. *Pentachlorophenol hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish and Wildlife Service Biological Report 85(1.17), Contaminant Hazard Reviews Report No. 17. 72 pp.

Phenol

Phenol is mainly a man-made chemical, although it is found in animal wastes and organic material. Phenol is a colorless or white solid when it is pure but it is usually sold and used as a liquid. The largest single use of phenol is production of plastics. It evaporates more slowly than water and dissolves fairly well in water. Phenol is also ignitable (ASTDR 1989).

Pregnant animals that drank water containing high levels of phenol gave birth to offspring that had low birth weights and birth defects. Dermal exposure to small amounts of phenol for short durations can cause blisters and burns on the exposed area. Spilling weak phenol solutions on large parts of the body (more than 25 percent of the body surface) can result in death (ATSDR 1989). The toxicity of dermal exposure to phenol is influenced by the size of the skin area exposed.

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for phenol*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs are virtually ubiquitous in nature, primarily as a result of natural processes such as forest fires, microbial synthesis, and volcanic activity. They have been detected in animal and plant tissues, sediments, soils, air, surface water, drinking water, and groundwater. Anthropogenic sources of PAHs in the environment include high temperature combustion of organic materials typical of processes used in the steel industry, heating and power generation, and petroleum refining.

Environmental concern has focused on PAHs, which range in molecular size from two-ring structures to seven-ring structures. The number of rings on the molecule strongly affects its biochemical interactions in the environment. Consequently, the fate, transport, and toxicity of PAHs correlate strongly with the size of the specific PAH molecule.

Relatively little information is known on the fate and transport of specific PAH compounds. Information on PAHs as a group is largely inferred from information on benzo(a)pyrene and mixtures of PAHs.

PAHs are moderately persistent in the environment and therefore may potentially cause significant effects to vegetation, wildlife and fish. The carcinogenicity of individual PAHs differs. Some lower weight compounds such as naphthalene, fluorene, phenanthrene, and anthracene exhibit acute toxicity and other adverse effects to some organisms, but are non-carcinogenic. In contrast, the higher molecular weight compounds are significantly less acutely toxic, but many are demonstrably carcinogenic, mutagenic, or teratogenic to a wide variety of organisms, including fish and other aquatic life, amphibians, birds, and mammals.

PAHs can be taken into the mammalian body by inhalation, ingestion or dermal contact. Acute and chronic exposure to carcinogenic PAHs have been shown to cause tumors in the stomach, lung, and skin. PAHs also have been associated with the destruction of hematopoietci and lymphoid tissues, ovatoxicity, adrenal necrosis, changes in intestinal and respiratory epithelia and immunosuppression.

The environmental effects of most non-carcinogenic PAHs are poorly understood. Available information suggests that these PAHs are not very potent teratogens or reproductive toxins. Effects include damage to the liver and kidney, and external effects of sebaceous gland ulceration.

Studies on PAH toxicity in birds indicated no mortality or visible signs of toxicity when fed 4,000 mg total PAH per kilogram of body weight for 7 months. In another study, toxic and sub-lethal effects were noted at concentrations of between 0.036 and 0.18 μg PAH per egg following application of various PAHs (e.g., chrysene and benzo(a)pyrene) to the surface of mallard eggs. Another study reported acute oral effect levels for the red-winged blackbird and house sparrow and acenaphthene, phenanthrene and anthracene LD_{50}values exceeded 100 mg/kg of body weight for these species.

Few ingestion-based studies have been conducted on mammals using PAHs. Neal and Rigdon (1967) conducted a study on mice for the development of forestomach tumors. Mice were fed between 0.13 mg/kg/day and 32.5 mg/kg/day of PAH for 110 days. The highest dose produced tumors in 90 percent of the mice. The NOAEL was calculated at 1.3 mg/kg/day and the LOAEL was 2.6 mg/kg/day (4 percent occurrence of tumors) (Charters et al. 1996).

A study conducted on nestling European starlings indicated that a dose of 100 mg/kg/day of 7,12-dimethylbenz(a)anthracene caused an 11 percent reduction in mean body weight, a 16 percent reduction in mean hemoglobin concentrations, and a 90 percent reduction in lymphocyte proliferation (Trust et al. 1993). A dose of 10 mg/kg/day caused no adverse effects to nestling birds. Adult starlings dosed as high as 300 mg/kg/day showed no adverse effects.

Charters, D.W., N.J. Finley, and M. Huston. 1996. *Draft report, preliminary ecological risk assessment, Avtex Fibers Site, Front Royal, Virginia.* U.S. Environmental Protection Agency, Environmental Response Team Center, Office of Emergency and Remedial Response.

Neal, J. and R.H. Rigdon. 1967. Gastric tumors in mice fed benzo(a)pyrene: a quantitative study. *Tex. Rep. Biol. Med.* 25:553-557.

Trust, K.A., A. Fairbrother, and M.J. Hooper. 1993. Effects of 7,12-dimethylbenz(a)anthracene on immune function and mixed-function oxygenase activity in the European starling. *Environ. Toxicol. and Chemistry.* 13:821-830.

Acenaphthene

Mice fed acenaphthene orally for 13 weeks showed adverse reproductive effects at a dose of 3500 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 350 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. For birds, data for benzo(a)pyrene was applied to this chemical.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs).* August.

Acenaphthylene

Information regarding acenaphthylene was not available in the literature. For mammals, data for acenaphthene was applied to this chemical. For birds, data for benzo(a)pyrene was applied to this chemical.

Anthracene

Mice fed anthracene orally for 13 weeks showed adverse reproductive effects at a dose of 10,000 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 1,000 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Mallards fed anthracene orally for 7 months showed adverse effects to the hepatic system at a dose of 228 mg/kg/day (Patton and Dieter 1980). This dose was considered a chronic LOAEL. A chronic NOAEL of 22.8 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs).* August.

Patton, J.F. and M.P. Dieter. 1980. Effects of petroleum hydrocarbons on hepatic function in the duck. *Comp. Biochem. Physiol.* 65C:33-36.

Benzo(a)anthracene

Information regarding benzo(a)anthracene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Benzo(a)pyrene

Female mice were fed benzo(a)pyrene during pregnancy. Adverse reproductive effects were found at a dose of 10 mg/kg/day (Sample et al. 1996). This dose was considered a chronic LOAEL. A chronic NOAEL of 1 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Mice fed benzo(a)pyrene orally for 19 to 29 days showed adverse reproductive effects at a dose of 1330 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 133 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Chickens were fed benzo(a)pyrene for 34 days. Adverse reproductive effects were found at a dose of 395 mg/kg/day (Rigdon and Neal 1963). This dose was considered a chronic LOAEL. A chronic NOAEL of 39.5 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs)*. August.

Rigdon, R.H. and J. Neal. 1963. *Fluorescence of chickens and eggs following the feeding of benzpyrene crystals*. Texas Reports on Biology and Medicine 21(4):558-566.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision*. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Benzo(b)fluoranthene

Information regarding benzo(b)fluoranthene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Benzo(g,h,i)perylene

Information regarding benzo(g,h,i)perylene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Benzo(k)fluoranthene

Information regarding benzo(k)fluoranthene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Carbazole

Information regarding carbazole was not available in the literature.

Chrysene

Information regarding chrysene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Dibenz(a,h)anthracene

Information regarding dibenz(a,h)anthracene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Fluoranthene

Mice fed fluoranthene orally for 13 weeks showed adverse effects to the hepatic system at a dose of 1250 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 125 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. For birds, data for benzo(a)pyrene was applied to this chemical.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs).* August.

Fluorene

Mice fed fluorene orally for 13 weeks showed adverse hematological effects at a dose of 1250 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 125 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. For birds, data for benzo(a)pyrene was applied to this chemical.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs).* August.

Indeno(1,2,3-cd)pyrene

Information regarding indeno(1,2,3-cd)pyrene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Naphthalene

Mice fed naphthalene orally for 13 weeks showed adverse reproductive effects at a dose of 1400 mg/kg/day (ATSDR 1995). This dose was considered a chronic LOAEL. A chronic NOAEL of 140 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Mallards fed naphthalene orally for 7 months showed adverse effects to the hepatic system at a dose of 228 mg/kg/day (Patton and Dieter 1980). This dose was considered a chronic LOAEL. A chronic NOAEL of 22.8 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs).* August.

Patton, J.F. and M.P. Dieter. 1980. Effects of petroleum hydrocarbons on hepatic function in the duck. *Comp. Biochem. Physiol.* 65C:33-36.

Phenanthrene

Information regarding phenanthrene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Pyrene

Information regarding pyrene was not available in the literature. Data for benzo(a)pyrene was applied to this chemical for both birds and mammals.

Volatile Organics

1,1-Dichloroethane

1,1-dichloroethane is a manmade liquid that is a vapor when released to the environment. It is used to make other chemicals, and to dissolve paints, varnishes, and grease. 1,1-dichloroethane does not dissolve easily in water but can evaporate easily to the air. 1,1-dichloroethane found in soils can evaporate to the air or can move to groundwater (ATSDR 1989). Brief exposures to high levels of 1,1-dichloroethane have caused death in animals. Longer exposures to 1,1-dichloroethane in the air have caused kidney disease in animals (ATSDR 1989).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for 1,1-dichloroethane*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

1,1-Dichloroethene

1,1-dichloroethene is a clear, colorless, manmade liquid with a sweet odor that is used to make other chemicals such as polyvinylidene chloride. 1,1-dichloroethene evaporates from water into the air where it is broken down quickly by compounds formed by sunlight. In water, 1,1-dichloroethene breaks down slowly and is not readily transferred to fish or animals. In soils, 1,1-dichloroethene either evaporates to the air or moves to the groundwater where it may be broken down slowly by organisms (ATSDR 1989).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for 1,1-dichloroethene*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

1,1-Dichloropropene

Information regarding 1,1-Dichloropropene was not available in the literature.

1,2,4-Trimethylbenzene

Information regarding 1,2,4-Trimethylbenzene was not available in the literature.

1,3,5-Trimethylbenzene

Information regarding 1,3,5-Trimethylbenzene was not available in the literature.

1,2,3-Trichloropropane

Information regarding 1,2,3-Trichloropropane was not available in the literature.

1,1,2,2-Tetrachloroethane

Information regarding 1,1,2,2-tetrachloroethane was not available in the literature.

1,2-Dibromo-3-chloropropane

1,2-dibromo-3-chloropropane is a colorless manmade liquid used in the past as a pesticide. It has not been used in the continental United States since 1979 and in Hawaii since 1985. It is used today for research. 1,2-dibromo-3-chloropropane dissolves in water and evaporates within a few days to a week to the air where it breaks down slowly. Most disappears in a few months. 1,2-dibromo-3-chloropropane does not adhere to sediments in streams, lakes and rivers. When in soil, it can leach to the groundwater where it remains for long periods of time. 1,2-dibromo-3-chloropropane present in surface soils can evaporate to the air. 1,2-dibromo-3-chloropropane may break down to simpler chemicals in soils and water (ATSDR 1991).

Agency for Toxic Substances and Disease Registry (ATSDR). 1991. *Toxicological profile for 1,2-dibromo-3-chloropropane.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

1,2-Dibromoethane

1,2-dibromoethane is a colorless liquid that is used as a pesticide and a gasoline additive to improve fuel efficiency. 1,2-dibromoethane is mostly manmade, but small amounts may occur naturally in the water. The USEPA banned most uses in 1984. 1,2-Dibromoethane evaporates into the air where it breaks down quickly. It dissolves in water and remains in the groundwater and soils for long periods of time (ATSDR 1991).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for 1,2-dibromoethane.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

1,2-Dichloroethane

1,2-dichloroethane is a clear, manmade liquid used to make vinyl chloride and other substances that dissolve grease, glue, and dirt. It is also added to leaded gasoline to remove lead. Small amounts of 1,2-dichloroethane evaporate from the water and soil into the air where it is quickly broken down by the sun. 1,2-dichloroethane in the soil will travel into the groundwater where it can stay for up to 40 days. Animals that ingest or inhale large amounts of 1,2-dichloroethane exhibit nervous system disorders and kidney disease (ATSDR 1993).

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological profile for 1,2-dichloroethane.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

1,2-Dichloroethene

1,2-dichloroethene is a manmade colorless liquid used in the production of solvents. 1,2-dichloroethene dissolves rapidly and almost all of it that is in surface soil or water will evaporate to the air. Once in the air, 1,2-dichloroethene has a half-life of 4 to 8 days. When present in deeper soils, 1,2-dichloroethene will move downward and possibly contaminate groundwater where it has a half-life of 13 to 48 weeks. Animals that breathed high levels of 1,2-dichloroethene exhibited lung and heart damage. Liver and lung damage and death are caused by ingestion of high levels of 1,2-dichloroethene by animals (ATDSR 1990).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for 1,2-dichloroethene.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

1,2-Dichloropropane

1,2-dichloropropane is a colorless, manmade liquid that is used currently in research and industry. 1,2-dichloropropane was used prior to the early 1980s as a soil fumigant and was found in some paint thinners, strippers, and finish removers. 1,2-dichloropropane degrades slowly in the atmosphere and soil. In groundwater, 1,2-dichloropropane has a half-life of 6 months to 2 years. Animals given 1,2-dichloropropane orally were seen to exhibit liver and kidney damage. Those given higher doses died (ATSDR 1988).

Agency for Toxic Substances and Disease Registry (ATSDR). 1988. *Toxicological profile for 1,2-dichloropropane*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

1,3-Dichloropropane

Information regarding 1,3-Dichloropropane was not available in the literature.

Cis- and Trans-1,3-Dichloropropene

1,3-dichloropropene is a colorless liquid that exists in two forms, cis-1,3-dichloropropene and trans-1,3-dichloropropene. Mixtures of these are used to kill nematodes that eat the roots of crops. Once in the soil, 1,3-dichloropropene is likely to be broken down into smaller molecules by biotic and abiotic processes. The resulting chemicals may also be harmful. In air and water, 1,3-dichloropropene is also broken down into smaller chemicals. Rats and mice fed large amounts of 1,3-dichloropropene got cancer and rats that breathed 1,3-dichloropropene had fewer pups per litter (ATSDR 1990).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for cis- and trans-1,3-dichloropropene*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

2,2-Dichloropropane

Information regarding 2,2-Dichloropropane was not available in the literature.

2-Butanone

2-butanone is a manufactured chemical but it is also present in the environment from natural sources. It is used in paints, glues, and as a cleaning agent. 2-butanone is also produced naturally by some trees and is found in some fruits and vegetables in small amounts (ATSDR 1992). It is also known as methyl ethyl ketone (MEK).

2-butanone enters the air during production, use and transport, and from hazardous waste sites. It dissolves in water and is broken down to a simpler chemical form in about 2 weeks. It does not adsorb to soil, therefore it is highly mobile and can infiltrate to the groundwater. It is not known to bioaccumulate in fish or animal tissues and does not biomagnify in the food chain (ATSDR 1992).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for 2-butanone*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

2-Chloroethyl Vinyl Ether

Information regarding 2-chloroethyl vinyl ether was not available in the literature.

2-Hexanone

2-hexanone is a clear, colorless liquid that is formed as a waste product of wood pulping. The liquid form evaporates quickly into air and dissolves easily in water. 2-hexanone is probably broken down into smaller products within a few days. Rats given 4700 ppm of 2-hexanone for over 14 days became paralyzed (ATSDR 1990).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for 2-hexanone*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

4-Methyl-2-Pentanone

Information regarding 4-methyl-2-pentanone was not available in the literature.

Acetone

Acetone is a manufactured chemical that is also found naturally in the environment. Acetone is used to make plastic, fibers, drugs, and other chemicals. It is also used to dissolve other substances. It occurs naturally in plants, trees, volcanic gases, forest fires, and as a product of the breakdown of body fat. Industrial processes contribute more acetone to the environment than natural processes (ATSDR 1994).

Acetone is transported from the atmosphere into surface water and soil by rain and snow. It also moves quickly from soil and water back to air. Acetone does not bind to soil or bioaccumulate in animals and is broken down by microorganisms in soil and water (ATSDR 1994).

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. *Toxicological profile for acetone*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Benzene

Benzene is a naturally occurring chemical produced by volcanoes and forest fires but is also a major industrial chemical made from coal and oil. Benzene is present naturally in many plants and animals. As a pure chemical, benzene is a clear, colorless liquid. In industry, benzene is used to make intermediate chemicals, to make some types of plastics, detergents, and pesticides, and as a component of gasoline (ATSDR 1987).

Benzene is released to the environment from both natural and man-made sources. Chemical degradation reactions limit the atmospheric residence time of benzene to only a few days. Biodegradation, principally aerobic, is the most important fate mechanism for benzene in water and soil (ATSDR 1987). Much of the benzene released to water will volatilize to the air. Transport to sediment is not likely to be a significant fate process. Benzene released to soil will either volatilize to the air or leach to groundwater (ATSDR 1987).

Benzene can be absorbed into the body following ingestion, inhalation, and dermal contact. Benzene must undergo metabolic transformation to exert its toxic effects. The toxic effects of benzene include hematotoxicity, immunotoxicity, ad neurotoxicity. Benzene is not teratogenic but does cause some reproductive effects such as reduced fetal weight. Benzene is genotoxic and is a known carcinogen (ATSDR 1987).

Agency for Toxic Substances and Disease Registry (ATSDR). 1987. *Toxicological profile for benzene. Draft.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Bromobenzene

Information regarding Bromobenzene was not available in the literature.

Bromodichloromethane

Bromodichloromethane is a colorless, heavy liquid that is formed as a by-product when chlorine is added to drinking water. Bromodichloromethane is also used in the production of other chemicals. Bromodichloromethane evaporates quickly and most that is released evaporates into the air where it is slowly broken down. Animals that have been fed quantities of bromodichloromethane have developed cancer of the liver, kidney, and intestines (ATSDR 1989).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for bromodichloromethane.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Bromoform

Bromoform is a colorless, heavy, nonburnable liquid used to dissolve dirt and grease and to make other chemicals. Bromoform is also produced when chlorine is added to drinking water. Bromoform is stable in the air but breaks down slowly into other chemicals. Bromoform present in soil or water is slowly broken down by bacteria. Long-term intake of bromoform can cause cancer in animals (ATSDR 1990).

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for bromoform.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Bromomethane

Bromomethane is a manufactured chemical that also occurs naturally in small amounts in the ocean where it is probably formed by algae and kelp. Commercially, it is used to kill a variety of pests including rats, insects, and fungi. It is also used to make other chemicals or as a solvent to get oil out of nuts, seeds, and wool (ATSDR 1992). Bromomethane is not known to bioaccumulate in plants or animals.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. *Toxicological profile for bromomethane.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Carbon Disulfide

The chief uses of carbon disulfide are for the manufacture of rayon and for regenerated cellulose film. Acute and chronic exposure to carbon disulfide affects the central nervous system.

Carbon Tetrachloride

Carbon tetrachloride is a clear liquid that was produced in large quantities to make refridgeration fluid and propellant for aerosol cans. Production of this chemical is being phased out due its harmful effects on the ozone layer. Carbon tetrachloride evaporates very easily and can remain in the air for several years. Carbon tetrachloride does not adhere to soil or sediment particles but instead will move to the groundwater where it will be broken down into other chemicals.

A 2-year study on the effects of carbon tetrachloride on reproduction in rats indicated a chronic NOAEL of 16 mg/kg/day (Alumot et al. 1976). This was the highest dose administered and no adverse effects were observed. A chronic LOAEL of 160 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. No data were found on the toxicological effects to birds from ingestion exposures.

Alumot, E., E. Nachtomi, E. Mandel et al. 1976. Tolerance and acceptable daily intake of chlorinated fumigants in the rat diet. *Food Cosmet. Toxicol.* 14:105-110.

Chlorobenzene

Chlorobenzene is a colorless liquid with an almond-like odor. This chemical does not widely occur naturally but is manufactured for use as a solvent and to produce other chemicals. Chlorobenzene can persist in soil for several months but will persist in air and water for only hours or a few days (ATSDR 1990).

A chronic study on the effects of chlorobenzene on dogs showed adverse effects to the liver at a dose of 273 mg/kg/day (IRIS 1998). This dose is considered a chronic LOAEL. A chronic NOAEL of 27.3 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No data were found on the toxicological effects to birds from ingestion exposures.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for chlorobenzene. Draft.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Integrated Risk Information System (IRIS). 1998. U.S. Environmental Protection Agency, Washington DC.

Chloroethane

Chloroethane is a man-made colorless gas with a sharp odor that is used mainly in the production of tetraethyl lead, a gasoline additive. Due to stricter government control on the amount of lead in gasoline, production of chloroethane has dropped in recent years. Chloroethane is also used in the production of dyes, cellulose, medicinal drugs, and as a solvent, refrigerant, and skin numbing agent. Most of the chloroethane released to the environment ends up in the atmosphere where it quickly breaks up by reactions with other substances. Smaller amounts are released into groundwater where it is believed to break down into simpler forms through reactions with water. Little is known about this reaction or how long it stays in the groundwater (ATSDR 1989).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for chloroethane*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Chloroform

Chloroform is a colorless or water-white liquid. Most of what is produced in the United States is used to make fluorocarbon 22, which is a cooling fluid for air conditioners. A lesser amount is used in the production of pesticides and solvents. Most of the chloroform that is released to the environment is transported to the air (ATSDR 1988).

A literature search was conducted on the toxicological effects of chloroform ingestion to mammals and birds. Ingestion-based studies were not available for birds.

A 13-week study of the effects of chloroform on livers, kidneys, and gonad condition in rats indicated a chronic LOAEL of 410 mg/kg/day (Palmer et al. 1979). At this dosage, both female and male rats developed gonadal atrophy. A dose of 150 mg/kg/day was determined to be the chronic NOAEL because no adverse effects were observed at this dosage.

Agency for Toxic Substances and Disease Registry (ATSDR). 1988. *Toxicological profile for chloroform*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Palmer, A.K., A.E. Street, F.J.C. Roe, A.N. Worden, and N.J. Van Abbe. 1979. Safety evaluation of toothpaste containing chloroform. II. Long term studies in rats. *J. Environ. Pathol. Toxicol.* 2:821-833.

Chloromethane

Chloromethane is a clear colorless gas that is produced naturally in the oceans and by microbial fermentation, and by industry to create other chemicals. Chloromethane evaporates into the air where it can remain for up to 2 years. If present in a landfill, it can leach through the soil and infiltrate groundwater.

Dibromochloromethane

Information regarding dibromochloromethane was not available in the literature.

Ethylbenzene

Ethylbenzene occurs naturally in coal tar and petroleum and is also found in many man-made products including paints, inks, and insecticides. Gasoline contains about 2 percent (by weight) ethylbenzene. Ethylbenzene is a colorless liquid that smells like gasoline. It evaporates at room temperature and burns easily. Ethylbenzene is most commonly found as a vapor because it evaporates easily into the air from water and soil. Once in the air, other chemicals help break down ethylbenzene into chemicals found in smog. This breakdown happens in about 3 days with the aid of sunlight. In surface water such as rivers and harbors, ethylbenzene breaks down by reacting with other compounds naturally present in water. In soil, bacteria break down ethylbenzene. It can also infiltrate groundwater since it does not readily bind to soil. Several studies indicate that ethylbenzene causes systemic effects in animals following inhalation exposure. The principal target organs appear to be the lungs, liver, and kidney, with transient toxic effects on the hematological system (ATSDR 1990).

A chronic study on the effects of ethylbenzene on rats showed adverse effects to the liver and kidney at a dose of 971 mg/kg/day (Wolf et al. 1956). This dose is considered a chronic LOAEL. A chronic NOAEL of 97.1 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1. No data were found on the toxicological effects to birds from ingestion exposures.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for ethylbenzene.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Wolf, M.A., V.K. Rowe, D.D. McCollister, R.L. Hollinsworth, and F. Oyen. 1956. Toxicological studies of certain alkylated benzenes and benzene. *Arch. Ind. Health.* 14:387-398.

Methane

Information regarding Methane was not available in the literature.

Methylene Chloride

Methylene chloride is an organic solvent with a sweet smell that is used as an industrial solvent, a paint stripper, and in the manufacture of photographic film. Animals given large amounts of methylene chloride have developed cancer (ATSDR 1989).

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *Toxicological profile for methylene chloride.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Styrene

Styrene is a colorless liquid used to make rubber and plastics. Billions of pounds of styrene are produced each year in the United States. It does not occur naturally in the environment. Styrene is quickly broken down in the air when ozone is present, but remains in the soil and water for several months (ATSDR 1991).

A 90-day study on the effects of ingestion of styrene on reproduction in rats indicated a chronic NOAEL of 35 mg/kg/day (Beliles et al. 1985). A chronic LOAEL of 350 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10.

In a 560-day study on the effects of styrene on the hepatic system of dogs indicated a chronic LOAEL of 400 mg/kg/day (Quast et al. 1979). Dogs given this dosage by gavage exhibited increased numbers of Heinz bodies, decreased packed cell values, and sporadic decreases in hemoglobin and erythrocyte counts. No adverse effects were observed a dose of 200 mg/kg/day. This was determined to be a chronic NOAEL.

No data on the toxicological effects of styrene on birds were found in the literature.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for styrene.* U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Beliles, R.P., J.H. Butala, C.R. Stack et al. 1985. Chronic toxicity and three-generation reproduction study of styrene monomer in the drinking water of rats. *Fundam. Appl. Toxicol.* 5:855-868.

Quast J.F., C.G. Humiston, and R.V. Kalnins. 1979. Results of a toxicity study of monomeric styrene administered to beagle dogs by oral intubation for 19 months. Report to manufacturing Chemists Association, Washington, D.C., by Health and Environmental Sciences, Dow Chemical USA, Midland, MI.

Tetrachloroethene

Tetrachloroethene (PCE) is a nonflammable liquid solvent widely used in the dry cleaning industry. Most of the PCE used is released to the atmosphere via evaporation. PCE has a relatively long (about 96 days) half-life in the atmosphere. PCE in water and surface soil will most likely volatilize to the air. PCE in subsurface soils may persist there or be leached to groundwater (ATSDR 1987).

PCE causes toxic effect in the liver, kidneys, and central nervous system. Hepatic, fetotoxic, reproductive, and genotoxic effects are also known. PCE is a know carcinogen (ATSDR 1987).

A 6-week study on the effects of tetrachloroethene on mice showed adverse effects to the hepatic system at a dose of 70 mg/kg/day (Sample et al. 1996). This dose is considered a chronic LOAEL. A chronic NOAEL of 14 mg/kg/day was determined in this study since no adverse effects were found at this dose. No data were found on the toxicological effects to birds from ingestion exposures.

Agency for Toxic Substances and Disease Registry (ATSDR). 1987. *Toxicological profile for tetrachloroethylene.* Draft. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Toluene

Toluene is produced as a by-product in the processing of gasoline and coke, and in the manufacture of styrene. Toluene readily degrades once it is released to the environment. It is readily broken down by microorganisms in the soil and evaporates quickly from the soil and surface water. Toluene can accumulate in aquatic organisms such as fish, shellfish, plants, and aquatic mammals. It is not known to biomagnify in food chains.

Studies on animals have shown that toluene can effect the central nervous system, liver, kidney and lungs. Studies using moderate to high concentrations of toluene indicate that toluene is a developmental toxicant, but not a reproductive toxicant (ATSDR 1994).

A literature search was conducted on the toxicological effects of toluene ingestion to mammals and birds. Ingestion-based studies were not available for birds.

A study on the effects of toluene on the reproduction of rats indicated a chronic LOAEL of 0.3 mL/kg/day (Nawrot and Staples 1979). Exposure to this dose via oral gavage during gestation significantly reduced fetal weights and significantly reduced embryo mortality. The chronic LOAEL was converted to a daily dose of 260 mg/kg/day (Sample et al. 1996). A chronic NOAEL of 26 mg/kg/day was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. *Toxicological profile for toluene*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Nawrot, P.S. and R.E. Staples. 1979. Embryofetal toxicity and teragenicity of benzene and toluene in the mouse. *Teratology*. 19: 41A.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision*. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Vinyl Chloride

Vinyl chloride is a colorless gas that is used mainly to produce polyvinyl chloride for the plastics and vinyl industries. Most releases to the environment are from atmospheric emissions and wastewater discharges. When released to the air, vinyl chloride has a relatively short half-life of 1 to 2 days. When released to water, volatilization is the primary fate process with half-lives of 1 to 2 days. Vinyl chloride released to soils will either volatilize to the atmosphere or leach to groundwater (ATSDR 1988).

The principal route of exposure to vinyl chloride is inhalation or ingestion of water containing the chemical. Adverse effects include hepatotoxicity, developmental toxicity, genotoxicity, and reproductive effects. Vinyl chloride is a known carcinogen (ATSDR 1988).

Agency for Toxic Substances and Disease Registry (ATSDR). 1988. *Toxicological profile for vinyl chloride*. Draft. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Xylenes

Xylene is primarily a man-made chemical that is produced from petroleum and coal. Xylene also occurs naturally in petroleum and coal tar, and is formed during forest fires. There are three forms or isomers of xylene including *meta*-xylene, *ortho*-xylene, and *para*-xylene.

Xylene evaporates and burns easily. Xylene does not mix well with water, however, it does mix with alcohol and with many other chemicals. Xylene is a liquid and it can leach into soil, surface water (creeks, streams, and rivers), and groundwater where it can remain for 6 months or longer before it is broken down into other chemicals. Because it evaporates readily, most xylene is transported to the air, where it lasts for several days and is broken down by sunlight into other kinds of chemicals.

Results of studies with animals indicate that large amounts of xylene can cause changes in the liver and adverse effects on the kidney, lung, heart, and nervous system. Short-term exposure to high concentrations of xylene causes death in some animals, as well as muscular spasms, incoordination, hearing loss, changes in behavior, changes in organ weights, and changes in enzyme activity. Long-term exposure to low concentrations of xylene has not been well studied in animals (ATSDR 1990).

A study on the effects of xylene on the reproduction in mice indicated a chronic LOAEL of 2.6 mg/kg/day (Marks et al. 1982). A dose of 2.6 mg/kg/day showed significantly reduced fetal weights and increased the incidence of fetal malformations. While the xylene exposure studies were of a short duration, they occurred during a critical lifestage. The highest dose that produced no adverse effects (2.1 mg/kg/day) was considered to be a chronic NOAEL.

Quail exposed to xylene in the diet showed chronic effects at an estimated dose of 405 mg/kg/day (Hill and Camardese 1986). A chronic NOAEL of 40.5 mg/kg/day was estimated by multiplying this chronic LOAEL by an uncertainty factor of 0.1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological profile for xylene*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Hill, E.F. and M.B. Camardese. 1986. *Lethal dietary toxicities of environmental contaminants and pesticides to Coturnix*. U.S. Fish and Wildlife Service Technical Report 2.

Marks, T.A., T.A. Ledoux, and J. A. Moore. 1982. Teratogenicity of a commercial xylene mixture in the mouse. *J. Toxicol. Environ. Health.* 9:97-105.